ECHNOLOGY DEPT.

TECHNOLOGY REVIEW

January 1958

v. 60 no. 3

No. 1 in a series

Right off the Wire

An all-electronic telephone exchange (said to be the first for commercial use) has no moving parts, is noiseless and can be used in explosive atmospheres. It includes a "memory" which will hold an incoming call.

Wire can be strung beside a railroad track by a new travelling crane at the rate of 60,000 feet per hour.

Simplex recently completed one of the largest and heaviest shipments of cable ever transported on one reel — nearly two miles of ANHYDREX XX insulated submarine cable weighing 60 tons.

A new rubber-like material is porous, but will contain liquids.

Boron, lithium, hydrogen peroxide and fluorine compounds are to be the fuels of a new bomber reported to be in the design stage.

Smog-causing chemicals from automobile exhausts can be eliminated by a chemical catalyst developed by an automobile manufacturer.

Improvements in the explosive rivet have made it noiseless.

Only the touch of a hand is needed to light a new lamp. The electricity in the hand does the work.

Thorium is about three times as plentiful as uranium. A new process for the production of reactor-grade thorium should lead to a reduction in the cost of atomic fuel.

A high-output ultraviolet lamp, for heating and air-conditioning ducts, is claimed to be 1,000 times more effective in killing viruses and bacteria than an equal amount of radiation from the sun.

The world's largest solar furnace is to be completed in 1959. It will produce temperatures as high as 8,000°F, which is about 70% of the temperature of the sun's surface.

An ultra-hard glass has been developed that retains its hardness up to 1508°F.

The cost of converting sea water to fresh water has been reduced from $1.50 to 60 cents per thousand gallons.

"Talk-back TV", a new advance in educational television, enables a pupil to ask questions of a teacher who is broadcasting from a distant room.

Scientists have been able to produce shock waves with speeds of more than 100,000 mph (above Mach 150) involving temperatures higher than 100,000°F.

Some 1958 automobiles are using aluminum instead of copper in battery cables.

The first deep sea telephone cables to utilize the revolutionary new Bell Laboratory vacuum tube repeaters were manufactured by Simplex. Minimum tube life is expected to be 20 years.

Danish trawlers are using nylon propellers. The four-foot, three-bladed size weighs only seventeen pounds and they reduce vibration, resist impact damage and corrosion.

A cell that generates electricity by the chemical action of oxygen and hydrogen has been announced. It avoids some of the disadvantages of both dry cells and storage batteries.

An airplane has been built which can change its shape while in flight for the purpose of testing aerodynamic configurations.

C-L-X (Sealex) is the name of a new, completely sealed, corrugated metallic cable sheath manufactured by Simplex. It is pliable, moistureproof, and permits cable engineers to select the most economical cable cores, while assuring the greatest mechanical protection available.

Observations of the aurora during the Geophysical Year show that it occurs simultaneously at both the North and South Poles. This definitely identifies it with the earth's magnetic field.

A miniature battery about the size of a paper clip is said to deliver a steady flow of current for 176,000 hours.

Shirtsleeve Service

Simplex recently completed an order for 4600 ft. of Anhydrex XX Parkway Cable. The Simplex man was on the spot to help with installation, which happened to be on a 9,500 ft. mountain in rough terrain. He helped design a reel mounting bracket (for holding up to 7200 lbs.) for the front of the tractor used for laying. He supervised the laying of two lengths 2200 feet long.

This case typifies the kind of cooperation that Simplex offers in order to assure correct installation and satisfactory service.

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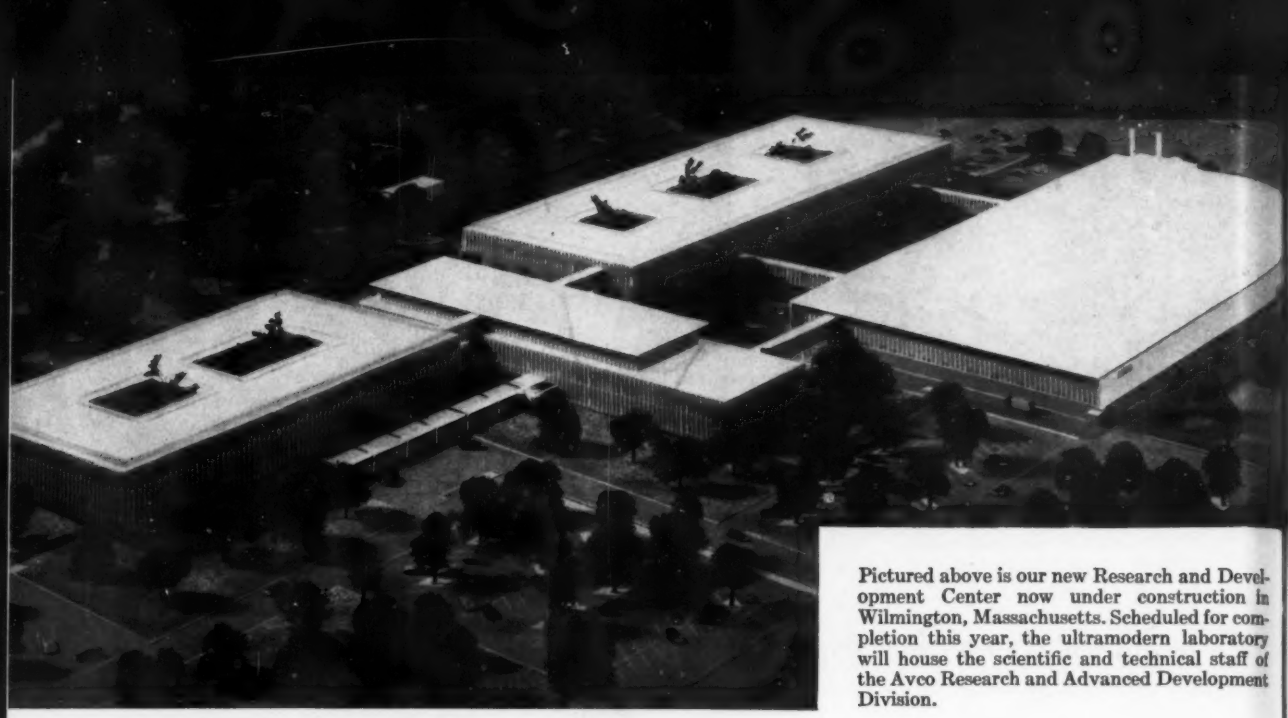

Pictured above is our new Research and Development Center now under construction in Wilmington, Massachusetts. Scheduled for completion this year, the ultramodern laboratory will house the scientific and technical staff of the Avco Research and Advanced Development Division.

Science and Progress at Avco—1957

Truly significant discoveries and technical progress are the goals of the Avco Research and Advanced Development Division. Some of the Avco RAD record of accomplishments are contained in professional papers in scientific and technical journals. Much of it is classified for reasons of military security. But the following public announcements serve to outline some of the steps taken by RAD—the "Breakthrough" Division of Avco—in pursuing its goal for 1957:

February 11, 1957.....Site Prepared for Avco RAD Center

April 5, 1957.....Avco to Make Hypersonic Shock Tubes for Industry, Universities, Other Research Groups

July 1, 1957.....Avco to Develop New Radio Pack Set for Marine Corps

July 2, 1957.....Prime $111 Million Contract Announced for Development by Avco of Nose Cone for Intercontinental Ballistic Missile

August 28, 1957.....Avco Shock Tube Research Has Produced Theoretical Breakthrough on 5000-Mile Air Force Ballistic Missile

November 23, 1957....Tiny "Building Blocks" Revolutionize Computer Design and Construction

December 3, 1957.....Avco to Build Air Force Combat Computer

Avco's record during the past year is significant from scientific, technical and business points of view. It has been made possible by sustained effort at RAD to maintain an atmosphere conducive to creative thinking and production of the highest order.

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Write to Dr. R. W. Johnston, Scientific and Technical Relations, Avco Research and Advanced Development Division, 20 South Union Street, Lawrence, Massachusetts.

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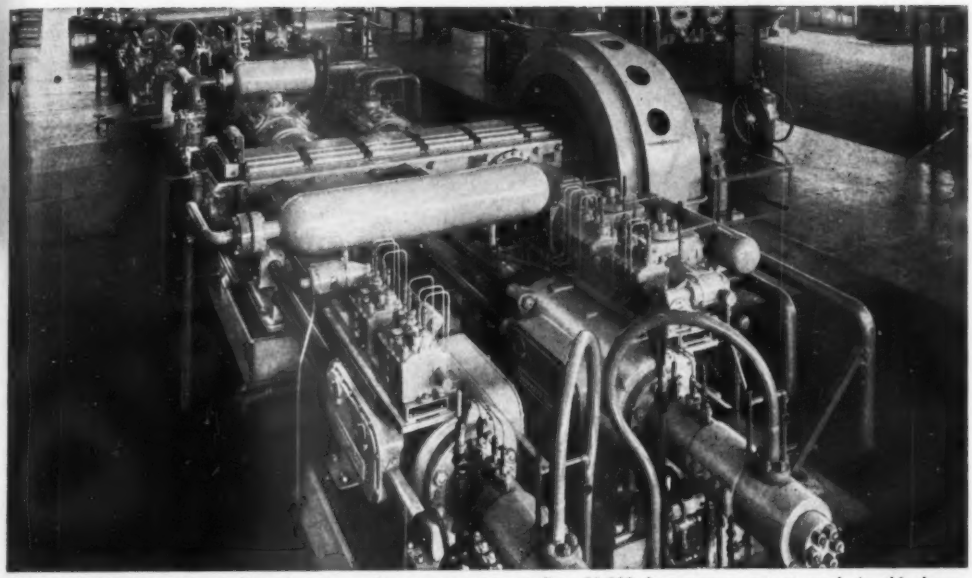

Seven electric-driven Ingersoll-Rand reciprocating compressors totaling 21,900 horsepower are at work in this large ammonia synthesis plant. The units in the foreground compress mixed gases to more than 12,000 pounds per square inch.

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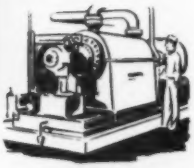

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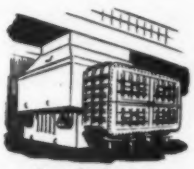
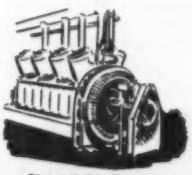
Air & Electric Tools



Steam Condensers



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THE TABULAR VIEW

Capitalizing on Ability. — Society – especially a technological one – can best capitalize on the work of men of high talent if its men of ability operate in an environment of creative and intellectually challenging opportunities. Management plays a considerable role in this matter, for aristocrats of mind cannot be successfully directed by proletariats of management. Such, in the main, is the thesis of FREDERICK HARBISON whose article in this issue (page 151) was originally delivered before the Twentieth Anniversary Conference of the M.I.T. Industrial Relations Section on November 1. Author Harbison was educated at Princeton University where he received the B.A., M.A., and Ph.D. degrees in 1934, 1938, and 1940, respectively. His research studies have been in the field of the labor problem in economic development in various countries, and he is co-author of *Patterns of Union-Management Relations* and *Goals and Strategy in Collective Bargaining*. Dr. Harbison has been professor of industrial relations and executive officer of the Industrial Relations Center of the University of Chicago. At present, he is professor of industrial relations and director of the Industrial Relations Section at Princeton University. He is a member of the American Economic Association and of the American Academy of Arbitrators.

Pinnacle of Reliability. — The problems of designing and installing a transoceanic telephone cable are vastly more difficult than that of producing a satisfactory cable for telegraphy, or even of providing transoceanic radio communication, and required years of research. How this feat was accomplished is told (page 155) by H. A. AFFEL who studied electrical engineering at M.I.T. and was graduated with the Class of 1914. After graduation, Mr. Affel spent two years as research assistant in the Department of Electrical Engineering at the Institute before joining the Bell System. From 1916 to 1934 he was a member of the Department of Research and Development of the American Telephone and Telegraph Company, and joined the Bell Telephone Laboratories in 1934. In 1944 he was made director of transmission

(*Concluded on page 138*)

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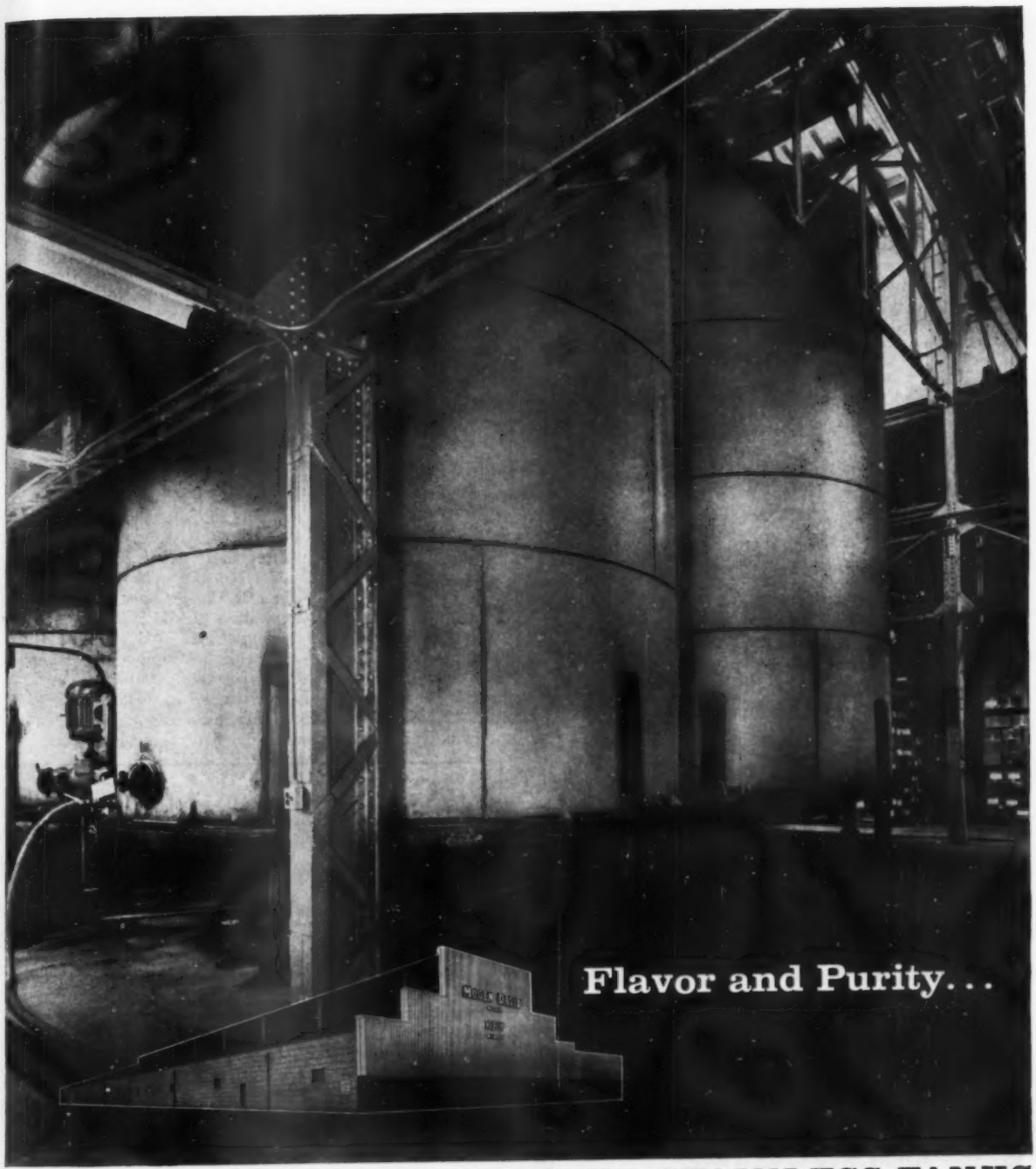

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THE TABULAR VIEW

(Concluded from page 136)

development, and at present Mr. Affel is assistant vice-president of the Bell Telephone Laboratories, Inc.

Decaying Era of Mobility. — A century ago canal routes provided one of the more popular ways of traveling through eastern portions of the United States, or of shipping one's products to market. For the most part, canals have long since given way to more modern modes of transportation, and their contribution to the nation's growth is a chapter of history now seldom opened for review. The era of planning, growth, competition, and final decay of three important canals in the northeastern United States is fetchingly presented (page 159) by FREDERIC W. NORDSIEK, '31, who traversed, on foot, much of the region about which he writes. Mr. Nordsiek is a native New Yorker whose foreign travel brought him to Cambridge for a four-year stint at M.I.T. from which he received his degree in Biology and Public Health in 1931. Since his graduation, Mr. Nordsiek has had wide experience in research and administration in the food industry and in public health activities. From 1943 to 1951 he was assistant director, Research Service Department of Standard Brands, Inc. Since 1951 he has been associated with the American Cancer Society as assistant secretary, Research Committee (1951-1955), and executive officer, Research Department (1955-1957). Currently, Mr. Nordsiek is special assistant, engaged in organizing and administering research grants programs. He has been an editorial associate of The Review since 1941, and has achieved considerable success as a writer on a wide variety of technical and nontechnical subjects.

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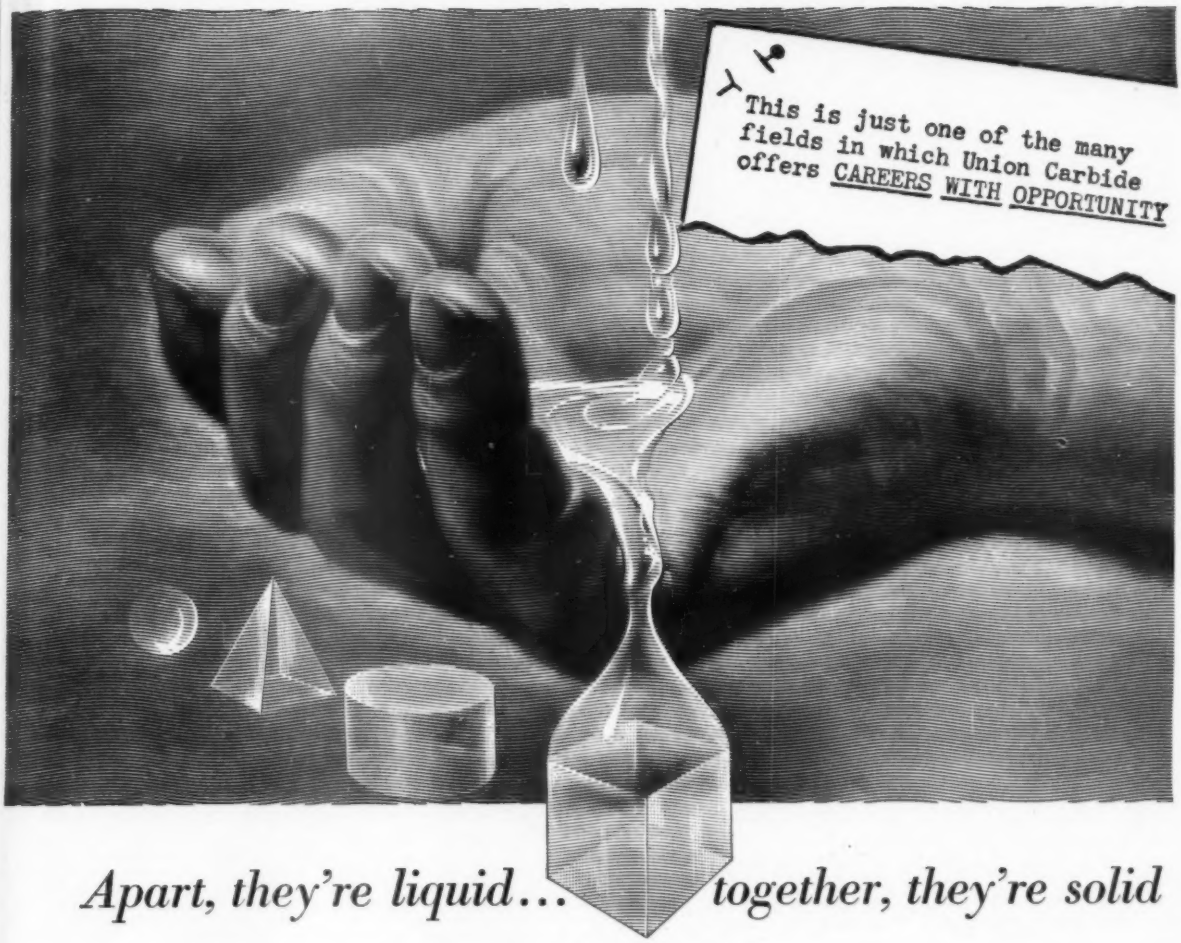

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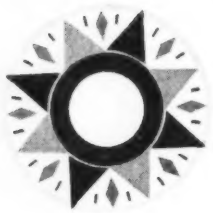

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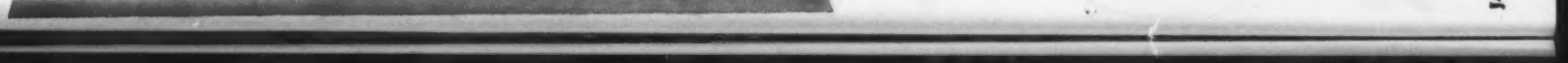

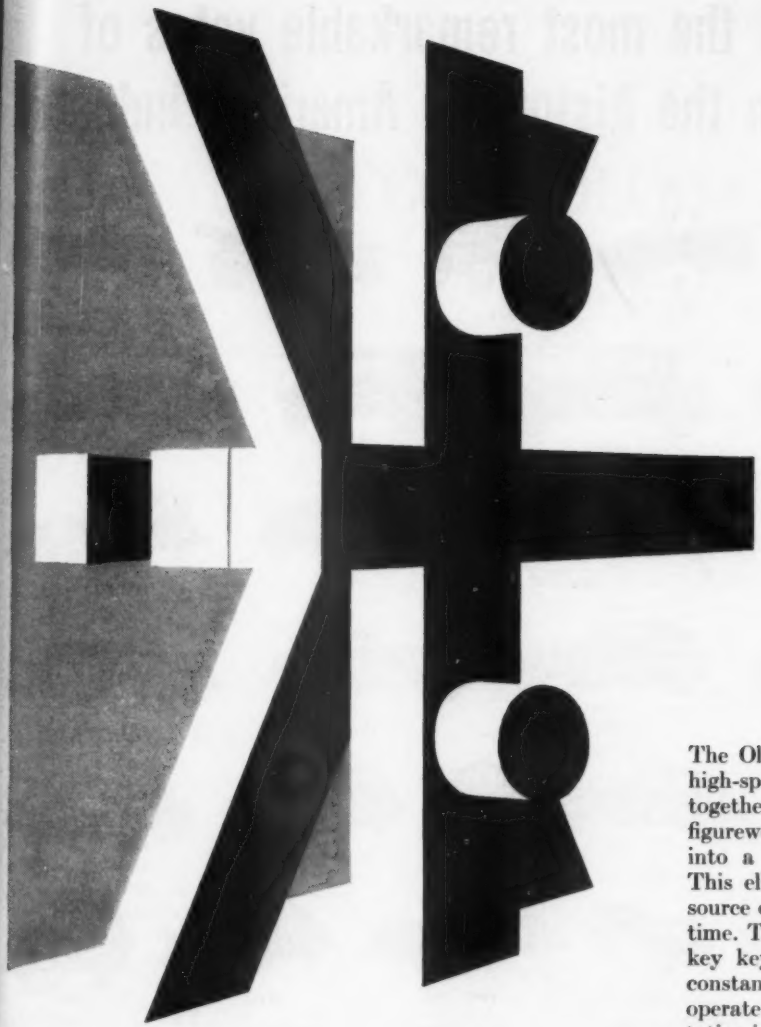

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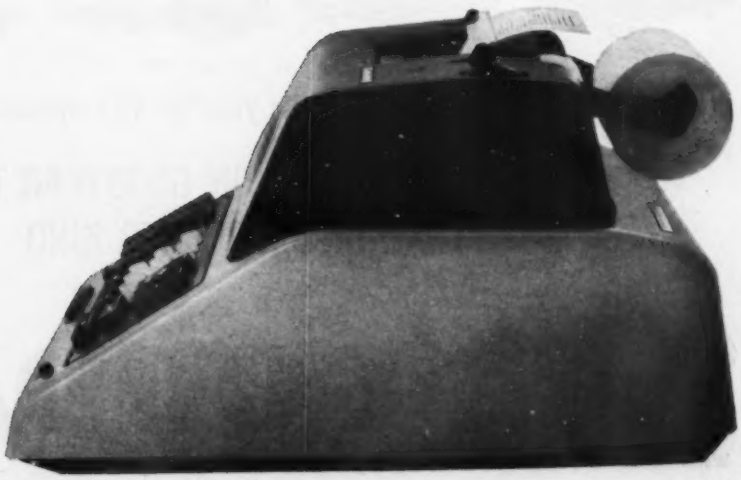

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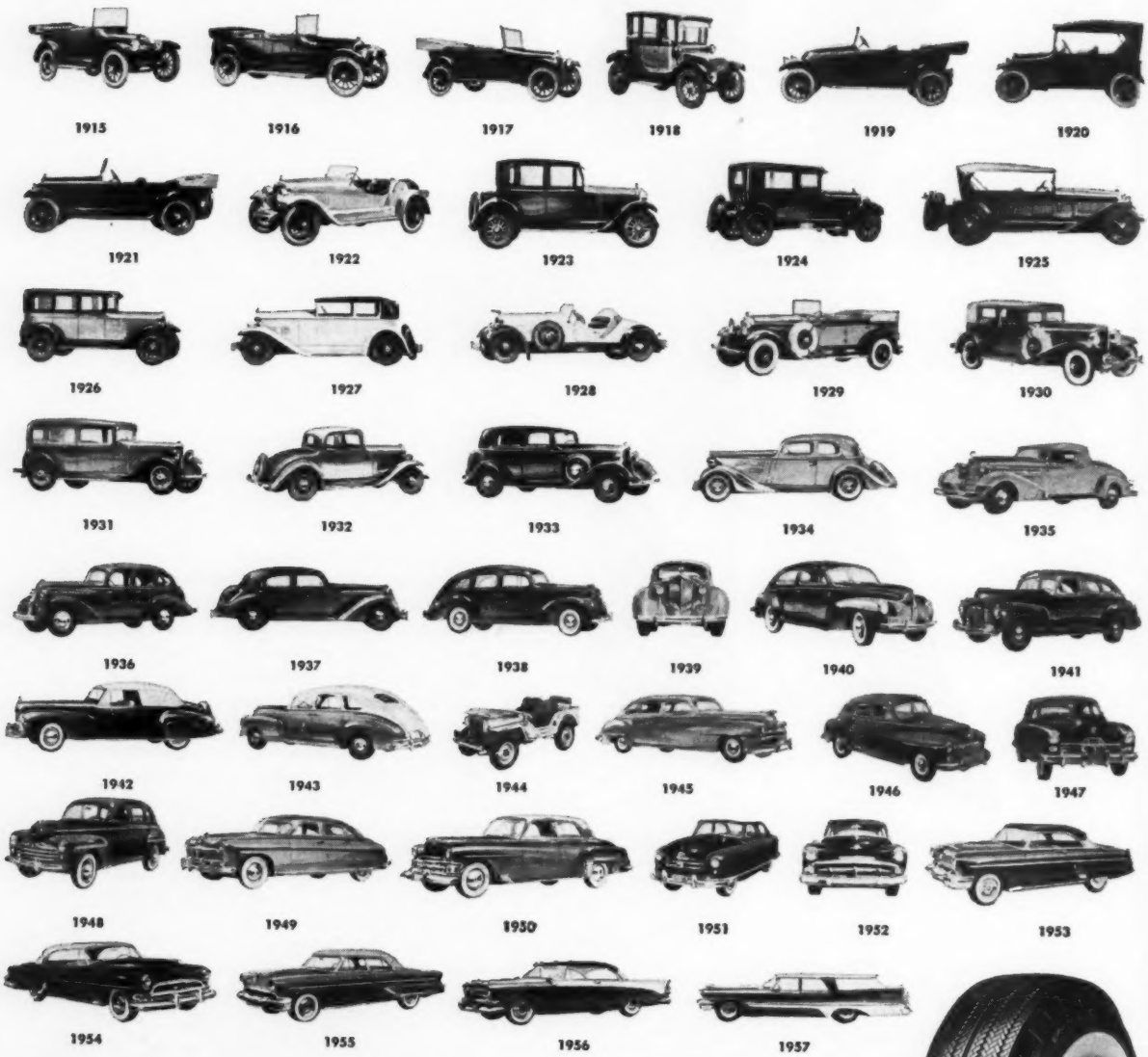

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THE TECHNOLOGY REVIEW

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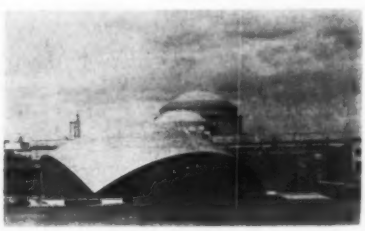

At the sign of the three concrete domes

Photograph by Oswald Cammann, '20

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M.I.T. Photo

Millstone Radar

With an 84-foot parabolic antenna atop a 90-foot tower, this new radar equipment is intended for research in problems of ballistic missile defense. One of its first tasks was to observe and compute satellite trajectories, as first announced by J. A. Stratton, '23, Acting President of M.I.T., at the November 18 meeting of the M.I.T. Club of New York.

The Technology Review

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The Trend of Affairs

New Radar Checks Satellites

■ Very large and high-powered, long-range radar equipment, recently developed at the Lincoln Laboratory of M.I.T., Lexington, Mass., has been detecting the Russian satellites, Sputnik I and II, at remote distances. These detections have been assisted by, and have confirmed the accuracy of, predicted positions calculated from radio observations by Lincoln scientists and engineers.

Since October 5, the day following the launching of Sputnik I, Lincoln scientists have observed by radio the passings of the Russian satellites over the northeastern United States. Starting on the first night with a single radio-receiving equipment at the Laboratory in Lexington, the Lincoln effort was expanded rapidly to include observations from four separate locations. Tape recordings of Sputnik signals have been made on both the 20- and 40-megacycle frequencies. Correlation of data from these multiple sightings has made it possible to pinpoint positions of the satellites with considerable accuracy.

The new radar equipment, located on Millstone Hill, Westford, Mass., first observed Sputnik II on the morning of November 7 at twelve minutes past five. From these observations, measurements of range, elevation, bearing and Doppler frequency were made. At this time the height of the satellite was 152 miles. But Sputnik observation is a "sideline" activity for the Millstone installation.

The Millstone radar was designed for use as a research tool, primarily for the study of problems in ballistic missile defense. It will provide valuable information on the operation and applications of high-power, long-range radar and will be of assistance in securing a better understanding of the radio effects of meteors and the aurora.

Development of the Millstone radar required new tools and techniques in the design of both the radar and its associated equipment. Advances were made in transmitter power, in large antenna and mount mechanics, and in other types of equipment.

The Millstone Hill facility will support co-operation between the U.S. Air Force and the Defense Research Board of Canada in research concerning the ballistic missile defense of North America.

Report of the Treasurer

■ The major trends and developments in Institute financial affairs for the fiscal year 1956–1957 are summarized below by Joseph J. Snyder, '44, Treasurer:

	1956-57	1955-56	Change
Academic operations	$ 19,489,000	$ 17,099,000	+ $2,390,000
Division of Sponsored Research	49,118,000	43,092,000	+ 6,026,000
Total funds	87,471,000	82,679,000	+ 4,792,000
Plant assets	41,309,000	37,980,000	+ 3,329,000
Gifts and grants	8,498,000	10,387,000	— 1,889,000
Investments — market value	128,086,000	123,683,000	+ 4,403,000
Investments — book value	85,314,000	79,390,000	+ 5,924,000

Operations

The operations of the Institute in 1956–1957 are set out in the following exhibit:

Revenues and funds	1956-57	1955-56
Tuition and other income	$ 6,458,000	$ 4,964,000
Investment income	1,793,000	1,890,000
Gifts and other receipts	4,215,000	3,859,000
Contract allowances for indirect expenses	5,230,000	4,580,000
Auxiliary activities	1,793,000	1,806,000
Total	$19,489,000	$17,099,000
Expenses		
Academic	$ 8,116,000	$ 6,901,000
General and administration	6,272,000	5,237,000
Plant operations	3,136,000	3,014,000
Auxiliary activities	1,965,000	1,947,000
Total	$19,489,000	$17,099,000

For three successive years prior to 1955–1956, academic expenses were in the six-million-dollar range. In 1955–1956 academic expenses approached the seven-million-dollar mark and for the fiscal year 1956–1957, exceeded $8,000,000. This uptrend reflects the program in recent years to increase Faculty salaries and the compensation of Institute employees. The expense of Faculty and employee benefits has doubled in the last two years. The expense of benefits for all M.I.T. employees, including the Division of Sponsored Research, is in general and administration expenses. Faculty salary expenses in 1956–1957 were

further increased by additional compensation provided for summer session teaching occasioned by the change for the Faculty from ten and one-half months' to nine months' teaching duties, with no reduction in basic annual salary.

Gifts

The gifts for 1956–1957 are compared to 1955–1956 in this table:

	1956-57	1955-56
Gifts for endowment	$ 2,381,000	$ 2,404,000
Gifts for buildings	731,000	1,134,000
Gifts for current use — invested	1,330,000	2,176,000
Industrial Liaison support	1,293,000	1,105,000
Other funds for current use	2,763,000	3,568,000
Total gifts	$ 8,498,000	$10,387,000

Substantial additions to endowment in 1956–1957 included bequests from Mary C. Emery, Arthur E. Fowle, Glenn L. Martin, and Henry D. Warren. The second part of the grant from the Ford Foundation for faculty salaries was received during the year. Receipts from the National Science Foundation and the Kresge Foundation made up the greater part of the gifts and grants received for buildings and equipment during the year. Gifts directly to the Alumni Fund of $356,179 are included in gifts for current use – invested and make up a part of the total of $641,371 credited by the Alumni Fund Office. Contributions for the Faculty Salary Adjustment Fund are included in gifts for current use – invested in the amount of $518,000. Funds for staff compensation were also increased by a gift from the Alfred P. Sloan Foundation, Inc., included in other funds for current use.

Funds

Endowment and other funds increased by $4,792,000 during 1956–1957:

	1956-57	1955-56
Endowment for general purposes	$34,902,000	$33,994,000
Endowment for designated purposes	19,882,000	17,090,000
Total endowment funds	$54,784,000	$51,084,000
Other funds	32,687,000	31,595,000
Total funds	$87,471,000	$82,679,000

Total endowment resources of $54,784,000 on June 30, 1957, compare with endowment funds of $41,248,000 five years ago and $34,287,000 ten years ago. New endowment resources were added during the year for Faculty salaries, for the support of academic departments, for undergraduate scholarships, and for plant operations.

Increases were recorded in funds for the Faculty Salary Adjustment Program, for academic department purposes, in funds for the funding of Faculty tenure salaries and related expenses now met with other resources, in net realized gains on investment transactions, and in the reserve of unallocated investment income. These increases were offset in part by decreases in building funds and unrestricted funds during the year.

With retirement funds included, the total book value of funds on June 30, 1957, was $96,378,000.

Plant Facilities

The Karl Taylor Compton Laboratories, including the Computation Center, and the nuclear reactor accounted for most of the $3,339,000 payments for construction added to educational plant in 1956–1957. Since the close of the fiscal year, the National Guard Armory on Massachusetts Avenue and Vassar Street was purchased by the Institute from the Commonwealth of Massachusetts, subject to an occupancy agreement of limited duration. The building funds on hand at the close of the year were fully committed but with gifts receivable were sufficient to meet all construction in progress and the cost of the Armory building. Construction of the David Flett du Pont Athletic Center adjoining the Armory will be undertaken during 1957–1958, and this structure will constitute the principal addition to academic plant in 1957–1958.

The book value of the educational plant of the Institute was $41,309,000 on June 30, 1957, compared to $37,980,000 on June 30, 1956.

Investments

The investment position of the Institute on June 30, 1957, and June 30, 1956, is presented in the following table, which is exclusive of the investments of the M.I.T. Pension Association and the Supplementary Retirement Plan.

	June 30, 1957		June 30, 1956	
	Book Value	Market Value	Book Value	Market Value
General Investments				
Bonds	$42,550,000	$ 39,957,000	$38,704,000	$ 38,183,000
Stocks	22,122,000	64,049,000	22,457,000	63,649,000
Real estate	11,863,000	11,863,000	10,503,000	10,503,000
Commercial paper	2,208,000	2,208,000	1,477,000	1,477,000
Total	$78,743,000	$118,077,000	$73,141,000	$113,812,000
Special investments	4,791,000	8,229,000	4,765,000	8,387,000
Student notes receivable	1,780,000	1,780,000	1,484,000	1,484,000
Total	$85,314,000	$128,086,000	$79,390,000	$123,683,000

Funds sharing in the income from the general investments earned 6.14 per cent on the average book value compared to 6.29 per cent last year. This year 5 per cent plus a special distribution of ½ of 1 per cent was allocated to the funds, which compares with 5 per cent and 1 per cent, respectively, last year. These special distributions have been made from the reserve of unallocated investment income. The total income on the general and special investments in 1956–1957 was $4,263,000, compared to $4,070,000 for the fiscal year 1955–1956.

The proportion of the general investments in bonds at market value was 33.8 per cent on June 30, 1957, and 33.5 per cent on June 30, 1956; but the proportion of investment income from bonds increased from 25.1 per cent to 30.1 per cent. At market values the proportion of the general investments in stocks decreased from 55.5 per cent on June 30, 1956, to 53.7 per cent on June 30, 1957; and the proportion of investment income represented by common stock dividends declined from 62.2 per cent to 57.0 per cent.

The increase in the funds of the Institute of $4,792,000 in 1956–1957 contrasts with the increase of $8,846,000 in 1955–1956. This reduced rate of growth was due in part to the receipt in 1954–1955 and 1955–1956 of funds for construction and other purposes to be expended in 1956–1957 and in succeeding years. Construction payments were $3,339,000 in 1956–1957 and $1,847,000 in 1955–1956. The growth in endowment funds in 1956–1957 was maintained at the level of the preceding year.

Gerard Swope: 1872–1957

■ Gerard Swope, '95, former President of the General Electric Company and an Emeritus Life Member of the M.I.T. Corporation, died in New York City on November 20. He was 84 years old.

An industrial leader noted for public service in social, civic, and humanitarian fields, Mr. Swope began his career in 1893 with a dollar-a-day summer job as helper in the General Electric repair shops in Chicago. After receiving his S.B. degree in Electrical Engineering at M.I.T., he began a 20-year climb from shopworker to vice-president and director of Western Electric Company.

International tributes to his World War I service with the War Department included the Distinguished Service Medal, the Medal of Chevalier of the Legion of Honor, and the Order of the Rising Sun.

Mr. Swope returned to the General Electric Company in 1919 as first president of the International General Electric Company, and three years later he was elected president of General Electric. Under his direction from 1922 to 1939, G.E. mass production expanded from incandescent electric lamps to a wide range of electric appliances for home use. Mr. Swope, also closely identified with the development of radio and radio accessories, was a director of 18 companies in the electric and power industry. After his retirement in 1939, he served as chairman of the New York City Housing Authority and, during World War II, resumed the presidency of the General Electric Company for two years.

In addition to his contributions in the fields of business, science, and engineering, he headed numerous organizations working for improved housing, industrial stabilization, unemployment insurance, and so on. For his public service he received the gold medal of the National Academy of Social Sciences in 1932 and the Hoover Medal in 1942. Mr. Swope was awarded honorary degrees by Union College; Rutgers, Colgate, and Washington Universities; Stevens Institute of Technology; and Technion-Israel Institute of Technology, Haifa. He served as term member of the M.I.T. Corporation from 1914 to 1919 and was elected to life membership in 1923.

Mr. Swope conceived of the Technology Loan Fund as a means of aiding students of limited financial means to borrow money to pay tuition expenses. The Fund, which Mr. Swope collected – and to which he was a substantial contributor – became operative in September, 1930, and has since proven to be a most effective method of encouraging deserving M.I.T. students to invest in their own self-development.

On the Horizon

February 4, 1958 – Midwinter Meeting of Alumni Association, M.I.T. Campus in Cambridge.

March 1, 1958 – 12th M.I.T. Alumni Regional Conference, Washington, D.C. (For further information, consult T. K. Meloy, '17, 3000 Arlington Boulevard, Falls Church, Va.)

March 13–15, 1958 – 10th Annual Fiesta, M.I.T. Club of Mexico, Mexico City, D.F. (For reservations, consult Clarence M. Cornish, '24, Margaritas 139, Villa Obregon, Mexico 20, D.F., Mexico.)

June 16, 1958 – 24th Alumni Day, 1958, M.I.T. Campus in Cambridge.

Repeat Performance

■ According to figures compiled here at the Institute, a grand total of 6,179 students (which includes 2,515 graduate students) is registered this fall, and of these, 909 are members of the Freshman Class.

A repeat performance is being staged by 29 of these freshmen, who have decided upon M.I.T. as the school of their choice, and who bear the same family names as M.I.T. Alumni. They are listed below.

With more and more emphasis being placed upon the need for sound engineering and scientific training, the old adage "like father, like son" might be hoped for by everyone.

Student	*Parent*
William J. Barrett	William J. Barrett, '16
John S. Cramton	Frank N. Cramton, '26
William W. Farr	William W. Farr, '26
Alden T. Foster	F. LeRoy Foster, '25
Freeman W. Fraim	Freeman W. Fraim, Jr., '32
Christopher T. Frank	Nathaniel H. Frank, '23
Reed H. Freeman	Reed Freeman, '38
Hugh P. Gilman	Donald B. Gilman, '32
Robert W. Goldthwaite	Clarence H. Goldthwaite, Jr., '35
Joseph Harrington, 3d	Joseph Harrington, Jr., '30
	Grandfather: Joseph Harrington, '96
Thomas N. Hastings	Russell Hastings, Jr., '34
	Grandfather: Russell Hastings, Sr., '10
Peter M. Kraus	Fred M. Kraus, '35
Frank M. Labouisse, Jr.	Frank M. Labouisse, '33
David H. LaForge	Louis H. LaForge, Jr., '37
David W. Latham	Allen Latham, Jr., '30
Robert W. Lewis	Frederick B. Lewis, '28
Richard L. Meehan	William Meehan, '26
Joseph H. Melhado, Jr.	Joseph H. Melhado, '27
Eric A. Moorehead	Eric O. Moorehead, '37
	Grandfather: Theodore P. Moorehead, '05
Richard E. Peterson	Carl M. F. Peterson, '29
James W. Poitras	Edward J. Poitras, '29
Charles W. Rogers	Robert C. Rogers, '33
Edgar C. Rust, 3d	Edgar C. Rust, Jr., '37
Marshall R. Sack	Melvin Sack, '28
Kenneth R. Scott	Arthur K. Scott, '29
Alan J. Stratton	Carl P. Stratton, '34 (Deceased)
Peter Ver Planck	Dennistoun W. Ver Planck, '28
Carl E. Wagner	Lawrence F. Wagner, '32
Warren C. Wetmore	Joseph W. Wetmore, '31

Dick Preston

During the celebration (June 7-10) of the 55th reunion of the Class of 1902, these 16 guests were photographed aboard a seaworthy motor launch in the bay, adjacent to Wentworth-by-the-Sea at Portsmouth, N.H., where the reunion was held. Reading from left to right, are: Burton G. Philbrick, Charles W. Kellogg, Mrs. Everett, Harold A. Everett, Arthur L. Collier, Mrs. Allen, Carlton B. Allen, Mrs. Marvin, J. Albert Robinson, Edwin E. Nelson, John R. Marvin, Mrs. Collier, Lewis E. Moore, Russell B. Lowe, Claude E. "Dan" Patch, and Alfred W. Friend (whose death on August 4 was noted with sorrow). Not seen in the picture above, but present at the reunion, were: Mr. and Mrs. William R. Greeley, and Norman E. Borden.

Individuals Noteworthy

■ Prominent in the news of late autumn were 38 promotions, elections, or appointments as set forth below:

Clarence D. Howe, '07, as a Director, Canadian Fund, Inc. . . . *Lyle M. Richardson, '14,* as President, Morton C. Tuttle Company . . . *Craig P. Hazelet, '18,* and *Philip C. Rutledge, '33,* as Directors, American Society of Civil Engineers . . .

Albert E. Bachmann, '21, as President, American Pulp and Paper Mill Superintendents Association . . . *Edwin T. Steffian, '21,* as President, Boston Society of Architects . . . *Arthur W. Davenport, '23,* as Project Manager in Brazil, Stone and Webster Engineering Corporation . . .

Hugh S. Ferguson, '23, as a Director, National Research Corporation . . . *Rodolphus K. Turner, '23,* and *Roland D. Glenn, '33,* respectively, as President and Vice-president — Development, Bakelite Company . . . *Philip D. Blanchard, '24,* as Vice-president, Wyatt, Inc., New Haven, Conn. . . .

Hartselle D. Kinsey, '24, as President, Union Carbide Olefins Company . . . *Denton Massey, '24,* as Vice-president and Director, AMF Atomics (Canada), Ltd. . . . *Charles H. Wardwell, '24,* as President, Continental Screw Company . . .

Clarence J. LeBel, 26, as Secretary, Audio Engineering Society . . . *George S. Mikhalapov, '26,* as Executive Vice-president, Brush Beryllium Company . . . *Harold W. Fisher, '27,* as Joint Managing Director, Iraq Petroleum Company, Ltd. . . .

Maurice C. Beren, '28, as President, Pyrotex Leather Company, Leominster, Mass. . . . *Solomon Horwitz, '29,* as a Director, American Institute of Steel Construction . . . *E. Ralph Rowzee, '30,* as President and Managing Director, Polymer Corporation, Ltd. . . .

Gordon S. Brown, '31, and *Donald G. Fink, '33,* respectively, as a Director and as President, Institute of Radio Engineers . . . *Stuart R. Fleming, '32,* as Vice-president of Ford, Bacon, and Davis . . . *John Lawrence, '32,* as Vice-president, Dresser Industries, Inc. . . .

Joseph L. Bird, '33, as Vice-president, Dynaform Corporation . . . *Norman E. Harris, '33,* as Vice-president and Sales Manager, Standard Plastics Company, Inc. . . .

Samuel A. Groves, '34, as a Director, Boston Manufacturers Mutual and Mutual Boiler and Machinery Insurance Companies . . . *John Sullivan, Jr., '38,* as President, Dayton Art Institute . . . *John R. Brown, Jr., '39,* as Vice-president, Colgate-Palmolive Company . . . *William R. Ahrendt, '41,* as Chairman and Treasurer, Integron, Waltham, Mass. . . .

James G. Buck, '42, as Director of Research and Development, Erie (Pa.) Resistor Corporation . . . *Stanley N. Golembe, '42,* as Executive Vice-president, Power Sources, Inc. . . .

Robert Oppenlander, Jr., '44, as a Principal of Cresap, McCormick, and Paget . . . *Jeptha H. Wade, 3d, '45,* as a Member of the Corporation, Museum of Science, Boston . . . *Philip R. Marsilius, '48,* as President, National Tool and Die Manufacturers Association . . .

John F. Matthews, '48, as Executive Vice-president, Forstmann Woolen Company . . . *Beverley J. Kirkwood, '49,* as a Partner of A. C. Kirkwood and Associates, Kansas City . . . *Donald G. O'Brien, '51,* as Chairman and President, American Measurement and Control, Inc., Waltham, Mass.

■ Special honors coming recently to Alumni and members of the Institute Faculty included:

To *Horace A. Crary, '94,* the Benjamin Rush Award to a layman for public health services, by the Pennsylvania Medical Society . . . to *Howard S. Morse, '03,* and *Whitney C. Huntington, '23,* honorary membership, by the American Society of Civil Engineers . . . to *Warren K. Lewis, '05,* its Gold Medal for distinguished achievement, by the American Petroleum Institute . . .

To *Irving W. Wilson, '11, Donald W. Douglas, '14,* and *Crawford H. Greenewalt, '22,* three of the "Fifty Foremost Business Leadership Medals" awarded by *Forbes Magazine* upon the occasion of its 40th Anniversary. As if further to emphasize Technology Alumni business leadership, Mr. Douglas was among the 50 similarly designated on the magazine's 30th anniversary; and the original list of 50, chosen by the late B. C. Forbes himself in the first issue published in 1917, included the late *Coleman du Pont, '84* . . .

To *Vannevar Bush, '16,* the annual New England Award, by the Engineering Societies of New England . . . to *Roderick K. Eskew, '21,* the Superior Service Award, by the U.S. Department of Agriculture . . . to *Arthur E. Raymond, '21,* the 1957 Daniel Guggenheim Medal, by the Institute of the Aeronautical Sciences . . . to *Hermon F. Safford, '23,* named as National Management Man for 1957, by the National Management Association . . .

To *John M. Campbell, '25,* the Harry L. Horning Award, by the Society of Automotive Engineers . . . to *Vladimir Haensel, '37,* the 1957 Professional Progress Award in Chemical Engineering, by the American Institute of Chemical Engineers . . .

To *Frank A. McClintock, '42,* the 1957 James Clayton Fund Prize, by the Institution of Mechanical Engineers, London . . . to *Glenn W. Stagg, '48,* selection as one of the nation's three outstanding young electrical engineers, by Eta Kappa Nu . . .

To *John Chipman,* Professor of Metallurgy, its Gold Medal and Senior Award, by the American Society for Metals.

■ Among the Alumni to whom birthday congratulations are appropriate during this month are two who are due to celebrate their 85th and six who will observe their 80th anniversaries, as listed below with their respective dates of birth:

January, 1873 – *Louis A. Freedman, '96,* on the 1st; and *Raymond M. Hughes, '98,* on the 14th.

January, 1878 – *Frank DeM. Gage, '00,* on the 14th; *Arthur W. Geiger, '00,* on the 14th; *Avery Robinson, '99,* on the 21st; *Warren W. Sanders, '00,* on the 22d; *Walter H. Sutliff, '99,* on the 23d; and *Roy G. Burnham, '00,* on the 29th.

With these eight, the rolls of the Alumni Association will include a total of 56 living nonagenarians and 577 octogenarians.

Silver Stein Dinner

■ The M.I.T. Club of New York held its fifth annual Silver Stein Award Dinner at the Hotel Biltmore on November 18, during which presentation of the much valued Silver Stein was made to C. George Dandrow, '22. The award, made to Mr. Dandrow for his valued contributions and services to Technology alumni affairs generally, and for his efforts in behalf of the M.I.T. Club of New York in particular, was the silver stein which Mr. Dandrow holds as shown in the illustration on this page.

Alfred T. Glassett, '20, lifelong friend of Mr. Dandrow, quite fittingly made the introductory remarks prior to the presentation. Basically, Mr. Glassett used the "This Is Your Life" approach, tracing Mr. Dandrow's career from the time both entered high school, through their years together at the Institute, and up to the present. Mr. Dandrow is vice-president for customer relations of the Johns-Manville Sales Corporation. He has been an active participant in Alumni Association affairs, serving as President of the Association in 1948–1949, and is a former president of the M.I.T. Club of New York.

Although James R. Killian, Jr., '26, President of M.I.T., originally had been scheduled to take part in the Silver Stein Award Dinner, his preoccupation with national defense matters in Washington, D.C., prevented him from attending. J. A. Stratton, '23, Acting President, was in attendance to bring greetings from the Institute. In his remarks, Dr. Stratton made the first public announcement of new radar facilities, developed at M.I.T.'s Lincoln Laboratory,

F. S. Lincoln, '22

Attending the Award Dinner in New York, when the silver stein was presented to Mr. Dandrow, were (left to right): H. E. Lobdell, '17, Executive Vice-president of the Alumni Association; J. A. Stratton, '23, Acting President and Chancellor of the Institute who brought greetings from M.I.T. to the guests at the dinner honoring Mr. Dandrow; C. George Dandrow, '22, Vice-president for Customer Relations of the Johns-Manville Sales Corporation; Alfred T. Glassett, '20, presenting the silver stein to Mr. Dandrow; Thomas C. Desmond, '09, New York State Senator and a previous recipient of the silver stein; and Eugene R. Smoley, '19, President of the M.I.T. Club of New York.

F. S. Lincoln, '22

Among the guests at the Silver Stein Dinner on November 18 were (left to right): Mrs. Miller and Theodore T. Miller, '22, Parke D. Appel, '22, and Mrs. F. S. Lincoln.

which were used to track the path of one of the earth's satellites. A photograph of the new radar antenna appears as the frontispiece of this issue, and a brief description appears on page 145.

When concluding his warm and heartfelt response to the tribute tendered him, and speaking of the growth of M.I.T. since 1916 when he was a freshman, Mr. Dandrow reminded his audience that "It is not easy to grow big effectively and gracefully," but stated that "M.I.T. has done just that."

Twenty-five Years Ago This Month . . .

■ With the advent of the new year of 1933, an even dozen Alumni were either retiring from or assuming the Presidencies of the following societies:

Sanford E. Thompson, '88, of the Taylor Society; *Charles N. Fitts, '91,* of the American Institute of Steel Construction; *Alonzo J. Hammond, '91,* of the American Society of Civil Engineers;

Frank P. McKibben, '94, of the American Welding Society; *Bradley Stoughton, '96,* of the American Electrochemical Society; *Arthur B. Lamb, '02,* of the American Chemical Society;

Andrey A. Potter, '03, of the American Society of Mechanical Engineers; *Harry P. Charlesworth, '05,* of the American Institute of Civil Engineers; *James I. Banash, '06,* of the National Safety Council;

Roy A. Seaton, '11, of the Society for the Promotion of Engineering Education; *John A. Allan, '12,* of the Canadian Mining Institute; and *Joseph W. Barker, '16,* of the Illuminating Engineering Society.

■ The Compton Cup, "appropriately named for Dr. Karl Taylor Compton as an honorary alumnus of Harvard University, former Head of the Physics Department of Princeton University, and President of Technology, was given by the student body of Technology to perpetuate an annual crew race between the three schools." This handsome trophy of English sterling silver, made in 1840 and obtained from the Rodman Wanamaker collection, stands 18 inches high and weighs 112 ounces.

■ Congratulations were being extended to *Charles H. Woodbury, '86,* for winning the Edwin Palmer Memorial Prize of $1,000 awarded by the National Academy of Design; . . . to *George E. Hale, '90,* as the recipient of the Copley Medal of the Royal Society, which honor had previously come to Benjamin Franklin for his "curious experiments and observations on electricity"; . . . and to *W. Spencer Hutchinson, '92,* Head of the Institute's Department of Mining Engineering, for his prediction at the annual meeting of the American Institute of Mining and Metallurgical Engineers that the use of oil and gas for energy production in the United States would double during the ensuing 20 years.

The color analyzer developed during 1932-1933 by Professor Arthur C. Hardy, '18, designed primarily to measure the color of opaque materials, such as paper, textile fabrics, ceramic products, and surfaces coated with paint, ink, or lacquer. Left to right: Vannevar Bush, '16, Vice-president and Dean of Engineering; Professor Hardy; President Karl T. Compton; Samuel C. Prescott, '94, Dean of Science; and Harry M. Goodwin, '90, Dean of the Graduate School.

M.I.T. Photo

Utilization and Development of High-Talent Man Power

Management is urged to become more sophisticated, to recognize individual ability, and to provide creative and intellectual opportunity for professional talent

by FREDERICK HARBISON

In the perspective of world history, our age may become known as the Century of Science. Within the last 50 years, man has learned to fly, to communicate globally by radio, telephone, and television, and to perform more than 10,000 complicated multiplications per second on an electronic computing machine. At mid-century there were developed in rapid succession nuclear energy, the intercontinental ballistic missile, and the earth satellite. And, in the foreseeable future, we may control the weather on this planet and start regularly scheduled flights to the moon. In a recent speech at the University of California, Professor Edward Teller pointed out that our scientific knowledge has doubled every 100 years since 1650. In other words, in each 100-year period since that time, we have learned more than in all previous times put together. Today we know twice as much as we did in 1850, but only half as much as we shall know in 2050.

This cumulative acceleration of knowledge is reflected in the changing occupational structure of the labor force. For example, between 1870 and 1950, the number of professional workers in the United States has grown three and one-half times faster than the nation's population, and three times faster than the labor force generally. If Teller's observations are correct, the proportion of highly trained people is bound to increase even more sharply in the future. Indeed, the application of new scientific principles, quite apart from their discovery, will require droves of scientists, engineers, and administrators of technical man power. Thus it is becoming clear that the central man-power problem of our time is that of generating and accumulating high-talent brain power. As a nation, we are engaged in a great and, in our history, unprecedented hunt for high talent.

In industry, the procurement of professional and scientific man power has become a highly competitive and expensive business. It has been estimated, for example, that the cost of hiring a young engineer and training him to a point of initial productiveness is probably in excess of $5,000. Company recruiters now swarm to our university campuses like locusts to devour our engineering graduates. And, even more important, companies are looking for high-quality people. They want the cream, not just the skimmed milk. The young man who boasts that he was graduated in the "upper 90 per cent" of his class does not interest today's talent-hungry recruiters. They are looking – not for the average man – but for the uncommon man. Never before in the history of America have so many people spent so much money and so much effort in the competitive search for men of high talent.

More Brain, Less Brawn

It is obvious that the trend in modern industry is to consume more and more brains and less and less brawn. Let me illustrate this trend by some examples taken from a survey of man-power utilization which we are making at Princeton.

The first is the case of a well-known chemical company. During the postwar period – 1946-1956 – this company expanded its output and sales by 75 per cent. Largely as a result of new processes and machinery, it was able in the same period to reduce its total employment by 10 per cent, and its manual work force by 17 per cent. However, it found it necessary to increase its technical, professional, and administrative staff by 20 per cent.

Next, let us take a steel company whose experience is fairly typical. Here we found that in the postwar period the employment of technical personnel increased over 125 per cent in comparison with an increase of less than 40 per cent in total employment. It showed a similar proportional increase in its managerial and administrative staff. When you look more closely at individual departments, the story is the same. For example, in one case the output per turn in the galvanizing department was increased nearly four times by introduction of continuous galvanizing lines. The total personnel required remained unchanged, but the supervisory and technical staff was increased by about 40 per cent, whereas the number of production workers declined by about 15 per cent.

On the basis of such studies in 30 companies in many different industries, we are coming to these tentative conclusions:

First, all kinds of technological change – including those popularly referred to as automation – increase the proportionate requirements for high-talent personnel – that is, for scientists, mathematicians, engineers, chemists, administrative staff specialists, and high-level managers. Automation may eliminate

unskilled and skilled manual labor, clerical employees, and certain types of routine supervision. It does so, however, by substituting both machinery and higher level human resources. Automation, in other words, always increases the requirements for brain power. The introduction of automatic computing machinery is a case in point. It eliminates labor in data processing; it also enables top management to have very quickly new kinds of information which it was unable to get before; but it usually leads to establishment of planning departments to program the data for processing and to make expert interpretations for top-level decision-making. This requires the employment of very high-level brain power. Obviously, then, the principal human consequence of automation is not the displacement of people but rather the tremendously increased quantity of high-talent man power which it consumes.

Our second tentative conclusion is that change and innovation of all kinds require heavy investment in high-level human resources. Wherever innovations are made – in new products, new processes, new techniques of control, new methods of marketing, or new ideas in management – there is a need for highly trained technical man power and for specialized administrative staff personnel.

From this we derive a third tentative conclusion: the more progressive and dynamic the firm or industry, the greater is its rate of increase of utilization of high-talent man power. For example, in the chemical, aircraft, and electrical industries we find the sharpest increases in utilization of top professional and technical personnel; railroads and shoe factories, on the other hand, show very little increase in proportionate utilization of high-level human resources except in a few departments where new methods and new techniques are being introduced.

On the basis of these three conclusions, we can draw this inference: Dynamic economic development involves a shift in man-power requirements away from manual and clerical operations and toward greater utilization of highly educated man power. Highly educated man power is in short supply, and there is no reason to believe that the demand for it will be satisfied in the next few decades. Therefore, the limiting factor on economic growth in the United States will probably be its capacity to generate high-level human resources rather than its ability to accumulate capital.

Dealing with the Uncommon Man

If industry faces the prospect of ever-sharpening shortages of high-talent man power, what measures can it take to protect itself? Among the more obvious are the following: (1) substitution of other human resources for highly trained professional personnel wherever possible; (2) use of incentives appropriate for development of the highest possible potential of the professional staff; and (3) development of more sophisticated management. Let us examine each of these very briefly:

Most companies now recognize that trained technical man power should be employed at its highest skill. An engineer should not be performing tasks of draftsmen, nor should he be burdened with routine clerical operations. Technical assistants can and should be employed to assist highly trained chemists and metallurgists. Likewise the productivity of high-talent man power may be increased by providing it with more secretarial and clerical help. I am sure that all of you know how to break down technical jobs in such a way as to separate out the less skilled tasks, and thus we need not discuss further this very obvious means of substituting less skilled personnel for the highly trained professional employee.

A more complicated problem is the utilization of professional personnel in supervisory and managerial capacities. Some people have suggested that, since good engineers, chemists, metallurgists, and scientists are so scarce, they should be employed only on professional work and that supervisory and managerial responsibilities should be assigned to others. In my judgment, this is a dangerous idea. As we all know, good supervisors and competent managers are usually even harder to come by than good professional people. Thus if the professional employee has those precious skills in human relations which qualify him to integrate and direct the work of others, he should be utilized in a managerial or executive capacity.

A much more critical problem is that first-rate engineers or scientists often turn out to be very poor and unhappy administrators, and a common costly mistake is to reward a professionally outstanding man by "promoting" him to a supervisory job for which he is not qualified. In this connection, the status system in American industry is peculiarly geared to making mistakes of this nature.

In most companies, pay, status, and recognition are much higher for managers and executives than for those engaged in strictly professional work. Thus, the engineer or scientist who would really prefer professional to supervisory work is under heavy social, psychological and financial pressure to conform to the notion that success is tied up with being a big manager or a high executive. Furthermore, if the man does not always feel this way, his wife and his friends are likely to equate executive positions with success. As a consequence, probably two out of three engineers or scientists who enter industry have, as their goal, the eventual entry into the executive or managerial hierarchy, but as nearly as I can determine, only one out of three is needed in this capacity. This can have serious implications. If the fellow does not get a managerial job, he may be dissatisfied, emotionally unadjusted, and quite unproductive. If he gets a managerial position for which he is not qualified, he may be even more disturbed, and his professional talents meanwhile are being wasted.

For this reason, some of the really smart companies today are taking measures to see that the pay, recognition, and status of top-level professional work is equal to that of even very high executive positions, including the floor space of offices, the thickness of carpets, the exposure of windows, and admittance to the executive dining rooms. Some companies refer to this as the parallel ladder system of advancement. In one or two companies I visited recently, it was apparent that, up to the pay levels of about $15,000

per year, there was fairly parallel treatment of the technically trained person employed in professional work and the technically trained person in supervisory work. However, the parallel ladder idea seems to break down at the very high salary levels. There are instances, of course, of highly paid vice-presidents or super-consultants who are strictly idea-men rather than managers, but these fellows are conspicuous because of their rarity. As a general rule, the professionals in industry do not enjoy the status in comparison with their associates that the professionals in universities command. If they did, the universities probably could not keep their key professors at the levels of pay they are now receiving! In all seriousness, however, I would say that many people with whom I talked in industrial research laboratories indicated that the question of the pay and status of the creative genius in comparison with managers or executives, is one of the thorniest, unsolved problems facing industry today. Here perhaps, industry might pick up some practical ideas by studying organization and administration of universities.

This brings us to the question of motivation of professional and technical employees. In this area, some companies have resorted too often to superficial cliches such as "treating everybody fairly as a human being" rather than to objective analysis of the factors involved. Above all, it is important to remember that in many respects, professional people are quite different from manual labor or clerical employees.

Of course, the matter of pay is as important for technical personnel as for anyone else. An adequate salary, or a fair wage, is simple enough to define for any individual: "At any time or in any society all of us might agree that it is approximately 25 per cent more than we are currently receiving and at least equal to the pay received by those other people who really aren't doing anything more important than we are." Most professional employees feel that they are underpaid in comparison with those in supervisory positions. It would appear, therefore, that a sound salary administration program might have as one of its objectives a plausible and convincing explanation to all concerned of the reasons, where they do exist, why supervisory and managerial personnel are more valuable to a company than persons employed in a professional capacity. My impression is that the question of salary for the professional employee, who is utilized in a non-managerial capacity, is often based more upon expedients than upon any really penetrating and objective analysis of the responsibilities involved and the state of the market.

Another important factor is recognition of the professional ambitions of the technical employee. The technically trained man is usually quite sensitive about what is "good" or "bad" from a professional standpoint. He prefers to work for a person who will recognize and respect his professional status. Furthermore, he wants to work for someone who can help him learn and develop professionally. The professional employee wants to perform tasks which will enable him to gain experience and insight in his profession. He wants recognition for his ideas; and he develops an interest in what is going on in other parts of the organization. In short, professional opportunity and being "in the know" are usually more important to the technical employee than the pay he receives.

Also, good professional people like to be loaded with work, if the work is challenging and if it offers opportunities for creative thinking. There is nothing so damaging to the morale of an engineer or a scientist than having too little to do. In this respect, there may be an important difference between professionals and other employees. Certainly, all evidence points to the fact that the morale of overworked professional employees is higher than those who are utilized below their capacity, and it is probably easier for top management to handle complaints arising out of assignment of too much responsibility than out of failure to assign sufficiently challenging tasks. The professionally trained man seeks above all else intellectual and creative opportunity. He develops a sense of fatherly interest in his ideas and suggestions, and he wants to see how they are being applied, or why they were rejected or pigeonholed. He prefers to work for an intelligent boss – or at least one from whom he can learn. He resents the superior who seeks to assert proprietorship over his suggestions or ideas and who tries to monopolize the channels of communication either with the company's top brass or the outside professional world.

The third and most critical problem in effectively utilizing and developing technical man power is sophisticated management. If industry is going to employ larger proportions of high-level professional people in the future, it is going to need smarter managers to supervise them. The effective co-ordination of brains calls for much more skill and education than the direction of brawn. You are all aware of the problems of supervising prima donnas. Furthermore, brainy people – particularly those who are bursting with new ideas – are sometimes uncomfortable and troublesome fellows to deal with. It is much easier to control the conformist than the idea-man. Most managers feel more secure if there are not too many of these intellectually restless people underneath them. The manager, after all, has some interest in the status quo, whereas the idea-man is continually trying to upset the apple cart.

What is the job description of a good manager of brainy people? Here is one I picked up in conversation a few weeks ago.

> The supervisor of professionally trained personnel, even though he may have technical training superior to his subordinates, must be a stimulator and integrator rather than the initiator and developer of ideas. His job is to generate the environment in which *the ideas of others can grow*. He is not the proprietor of the shop, nor is he the kind of guy who gives the orders. He is a chairman, but not a boss of his unit. And while encouraging all sorts of individual initiative and listening at times to all sorts of crazy ideas, he must find some way, for God's sake, to keep the boys on the reservation!

It is impossible to think of a program of effective recruitment and development of technical man power without considering first the more fundamental problem of how to develop the kind of managers who are equal to this very difficult task.

The problems, then, are fairly easy to define. Since high-talent man power is now very scarce and likely to be even scarcer in the future, companies must find a way to effectively utilize those engineering and scientific brains which they will be able to secure and retain. This involves the substitution of less-skilled human resources for technical brains wherever possible, the development of the professional employee to his highest possible capacity, recognition of the factors which motivate professionally trained people, and more intelligent and sophisticated management.

Differentiate to Motivate

We have discussed some of the problems involved in the efficient development and utilization of high-level man power: let us turn now to measures for solving these problems. Here we can start by simply making a check list of policies and practices which one finds in the most progressive and advanced companies.

The major concern of progressive companies is the formulation of a program for *effective utilization of existing technical man power.* This must be clearly developed as a prerequisite for any workable strategy of recruitment and placement. Indeed, the recruiting of people without a sound program for utilizing them is like pouring 100-proof whiskey into those paper cups which are supplied on Pullman cars! It will not be long before it all oozes out! The elements in a good utilization program are enumerated in the following seven paragraphs:

1. A study of probable requirements for the future – perhaps for the next five or 10 years. Here, one must be careful to estimate the changing quantitative proportions in requirements for high-level technical personnel. Most companies seem to assume that in the next five to 10 years the structure of their man-power requirements will remain unchanged. But, if the history of past decades is any guide, this assumption is nearly always wrong. It is also important to assess the changing qualitative requirements for scientific and engineering personnel. In other words, will you need tomorrow the same kind of genius which you are trying to find today? This, of course, is a more difficult question, requiring more judgment than statistics.

2. An analysis of the kind of management necessary to supervise technical personnel, and the formulation of a program for training the required managers. In effect, this is just one facet of the broader problem of general management development. Companies which have good manager-development programs usually are on top of this one.

3. Development of a sound and objective plan for determining the pay, status, avenues of advancement, and criteria of promotion of technical personnel, taking into account specifically the question of whether or not certain professional jobs should be rated higher or lower than managerial jobs. In most cases, this requires an agonizing reappraisal of certain assumptions underlying traditional salary classification systems. Very few companies have really faced this problem, but many because of mounting pressure, are on the brink of doing so.

4. A rigorous system of determining just where technical and professional man power is critically needed and why other resources cannot be substituted for it. This usually involves scrutiny of stated departmental requirements by both plant or division managers and central office personnel. Most companies find this easier to say than to do. Some encounter resistance in providing the necessary stenographic and junior technical assistance which fully utilized professional man power may require.

5. The development of an inventory of challenging tasks and opportunities for scientific and engineering man power. This is the kind of thing which makes a company or an industry glamorous in attracting new blood. The aircraft and electronics industries appear to excel here.

6. Provision of appropriate training and self-improvement opportunities for persons who wish to go upward in their respective professions. Most progressive companies today are quite liberal on this score, both in paying direct costs of advanced education and in providing compensated time.

7. Development of a system of communication between the technical staff and management, giving particular attention to the special factors which motivate the professionally trained individual.

Most companies agree that these steps are desirable. However, very few companies do these things until the pressure becomes so great as to threaten their competitive position. Others may wait until the technical staff threatens to become unionized.

The next concern, of course, is the development of a workable system of recruitment and orientation of new technical personnel. This should be easier if the utilization policy has been carefully formulated. Many colleges and universities have the impression that the campus recruiters sent out by some corporations really do not know what kind of men to hire because the companies do not really know how they will use them after they are employed. At this point, let me say a few things from the viewpoint of the suppliers of your future brain power.

Frequently, recruiters pay too much attention to labels, such as degrees and practical courses, and too little to the essential qualities of character, mind, and spirit of candidates. There has been too much emphasis on hiring college graduates as replacement parts for the existing industrial machine rather than on the quest for men of talent, ideas, and capacity for intellectual growth. After all, our colleges do not train engineers; they educate people for engineering. The training in the practical application of engineering principles is almost solely the responsibility of industry. The task of the college is to give a man broad and basic – and also theoretical education. In a sense, the college can do no more than build intellectual sensitivity into a man – just as color sensitivity is built into the finest photographic films. The development of the skills of the engineer or the scientist takes place only after exposure to the light of practical experience on the job. However, no amount of exposure and practical experience can develop really high talent in a mind which has been sensitized only to simple black and white over-

(Continued on page 170)

Deep-Sea Transoceanic Cable Telephony

Submarine cable, providing 36 simultaneous speech channels, uses tubes designed to operate unattended for 20 years on ocean bed

by H. A. AFFEL

THE first deep-sea telephone cable system has been in operation between North America and Europe since the fall of 1956. Within that time the telephone calls between here and the United Kingdom have just about doubled. And the end is not yet in sight. Some of this is normal growth, but a larger part is evidently the result of adding 36 more telephone circuits to those previously provided only by radio. This more than doubles the total number, and the "circuits are busy" situation occurs less frequently. A vital factor in the increased traffic has undoubtedly been the greater continuity of service provided by the new cable in comparison with the previously existing radio telephone circuits.

Another deep-sea telephone cable system, also of considerable length, has been put into operation this fall between the United States and the Hawaiian Islands. This transpacific cable is similar to the transatlantic telephone cable and undoubtedly will have a comparable effect on increasing traffic between the mainland and Hawaii, for here too greater continuity of service is provided by cable than by radio circuits. In both cases, the deep-sea cables are similar, and a description of the earlier transatlantic circuit will suffice to indicate some of the engineering and economic factors that had to be solved in providing this new, long-distance telephone service.

The cable circuits are engineered to insure, for 100 per cent of the time, the kind of transmission provided by the best overland telephone circuits. In the case of the radio circuits, the performance also approaches that provided by the best grade of wire transmission, but the North Atlantic radio transmission path is particularly subject to serious variations, between sunlight and darkness – and during magnetic storms, the result of sunspots and other unknown phenomena. These effects mar the quality of transmission and frequently result in complete interruption of service.

Why have we not had deep-sea telephone cable transmission before, just as we have had deep-sea telegraph transmission for nearly 100 years?

To a communication engineer it is a case of being "between the devil and the deep blue sea." The "devil" in this case is the problem of overcoming the losses that result when trying to transmit telephone currents over a long wire circuit. The deep blue sea is exactly that – how to place in the ocean and keep operating the necessary conductors and equipment to do a satisfactory job.

In the comparison between radio and cable, a crude analogy may be useful. If you were trying to communicate by voice with a friend in an open field, a quarter of a mile away, you could probably succeed fairly well by putting more lung power behind your words than if your friend were in the same room. If you tried to improve the situation by directing your voice into a small pipe stretched between the two points, the listener would probably pick up more of what you said from the air than from the end of the small pipe – because the pipe exacted too high a toll for its guidance of the sound waves.

Well, it is something like this in the case of radio versus cable for very long distances. The cable has more loss, or attenuation, than the radio circuit. You can put enough energy into the sending antenna of a radio station – it takes many kilowatts, and Nature has to be co-operative – and the receiving station at the distant end will, with sufficient amplification, produce useful sound.

In the case of the long cable, speech tones are higher in frequency than telegraph signals and suffer greater losses. For a speech channel, if one applies considerable energy, even to the point where the insulation of such a cable almost breaks down, scarcely an audible signal comes out at the distant end.

You may ask why cannot one put in only reasonable amounts of power at the sending end of such a cable and make up for the weakness of the voice at the distant end by the use of very powerful amplifiers to restore its volume. But Nature is obstinate. There is another "devil" in reserve. Except at absolute zero temperature (minus 273 degrees C.), the electrons in the conductor are continually moving around in a random fashion. They produce tiny variable voltages which, however small, are real and can be heard as noise in telephone receivers with sufficient amplification. This sets a practicable limit on the amount of amplification that can be employed. A telephone signal can readily be buried by this so-called thermal noise if the amplification exceeds a predictable amount.

Well, what is the answer? It is to apply amplification in a long cable circuit, not only at the end of the long circuit where the voice signal may perhaps be lost in the thermal noise but, as is the practice in long overland circuits, at intervals which are sufficiently short that the desired voice energy never drops so low that it approaches the thermal noise, or any other noise sources.

In overland transmission, this is comparatively simple. It merely means establishing so-called repeater stations with amplifiers in the circuits to boost

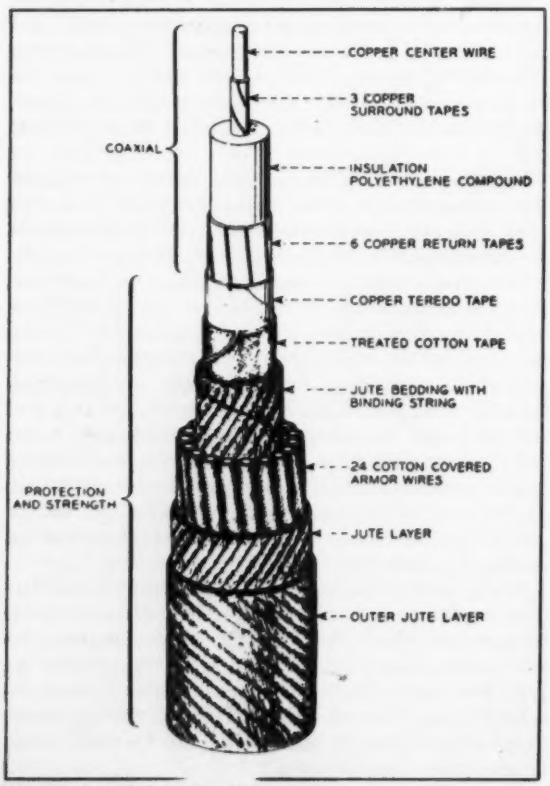
the speech power as needed. Sometimes these repeaters are 100 miles apart. In some types of wire circuits they may be as close together as four miles.

But putting amplifiers in a deep-sea cable system is another matter. It took about 25 years of research and development work by the Bell System to solve this problem with the required service reliability.

At the start of the project it was evident that the relatively high cost of submarine cables made it highly desirable that several channels, rather than a single telephone circuit, be provided. Several channels can be provided over a single set of conductors by using so-called carrier systems with a different frequency assignment for each channel. But this takes frequency range – the required spectrum being in proportion to the number of channels. In turn, this means greater cable losses and makes the amplifier problem even more difficult.

As to how to get amplifiers in a circuit across the sea, a good deal of preliminary thinking was done, including exploring the possibility of floating or underwater buoyed repeater stations to which the cable links would be attached. But the decision was reached to try to associate the repeaters intimately with the cable at the bottom of the ocean.

A particular structure was envisioned which, it was hoped, would make the laying of the cable – never a simple matter – as uncomplicated as possible. The housing for the apparatus necessary to amplify the feeble speech sounds was visualized as a long flexible tube, connected in such a fashion that it represented but a bulge in the cable itself. It should be stored in the hold of a ship with the cable, and payed out around the drums and over the sheaves that form a regular part of a deep-sea laying technique. Great care is needed to be certain that the cable goes in the right place on the ocean bed without kinks or stresses that may jeopardize its life.



Bell Telephone Laboratories, Inc.

Fig. 1. Structural features of deep-water type of cable. (Approximate diameter, 1¾ inches.)

In more detail, to the pioneers the problem appeared something like this:

(1) Devise an amplifier which has in it parts something like the typical small radio set and house it in a flexible tube not much larger than the cable itself, capable of withstanding water pressures without leakage up to about 10,000 pounds per square inch.

(2) Have the cables attached to each end and able to withstand a pull of several thousand pounds without ripping the amplifier apart.

(3) At the same time, supply each amplifier with power transmitted with the speech currents over the cable itself. Several dozen such amplifiers strung along the cable must be supplied with power at the same time.

(4) Furthermore, do not neglect to design each component in the amplifier, and the structure which houses it, to have a very long life (20 years or more) under continuous service. Otherwise it may be necessary frequently to pull up the cable and replace the amplifier or its components.

With all of these requirements it is not difficult to see why it took so many years to achieve and fully test a design to a degree which would warrant the risk of completing a transatlantic cable installation costing more than $40,000,000.

The objectives were achieved and the transatlantic cable has, as noted, been in successful operation for some time. It may be added, also, that a pilot installation of the same general design, over a shorter circuit, has been in operation for more than seven years between Key West, Fla., and Havana, Cuba. A similar type cable installation between Seattle, Wash., and Ketchikan, Alaska, was completed early in 1957 to improve commercial and military services to that territory. Furthermore, as noted, an installation between the Pacific Coast and Hawaii, identical in principle but somewhat longer than the transatlantic cable, was put in operation early in October.

All of these deep-sea installations employ essentially the same underwater repeater techniques. Actually, there are two cables, one for each direction, laid from 10 to 20 miles apart on the ocean floor. Repeaters are spaced about 40 miles apart. For example, in the transatlantic cable the Newfoundland-Scotland span is about 2,000 miles. Therefore 51 repeaters are needed in each direction.

A word about the deep-sea cable itself. Modern cables do not look so much different than they did in 1858 when Cyrus Field played a part in laying the first telegraph cable. They consist essentially of a fairly heavy copper conductor surrounded by flexible insulation to keep out the sea water, and then are usually covered with jute and one or more servings of steel wire to supply longitudinal strength and to resist abrasion.

But the modern cables have really been improved in some very important ways which, in particular,

help their use for telephony. First, the current is now given a return path by copper tapes forming a coaxial cylinder over the insulation. This return path, in place of a sea water return, reduces the loss and makes the cable circuits less susceptible to induction from other cables, static, and so on. The second important improvement in cable design is the use of better insulation. The older telegraph cables used gutta-percha. The new cables are made from a high quality polyethylene which improves the transmission considerably, particularly for high frequencies.

A cross-section of the deep-sea portion of the transatlantic cable is shown in Fig. 1. The shore ends are somewhat fatter because more steel wire protection is added on the outside to take care of occasional situations where the anchors of ships may snag the cable. Rocks and icebergs are also hazards. Cable routes are selected to minimize the difficulty from ships' anchors and also from trawlers which, in their effort to snare fish from the deep, have often interrupted transatlantic telegraph communication.

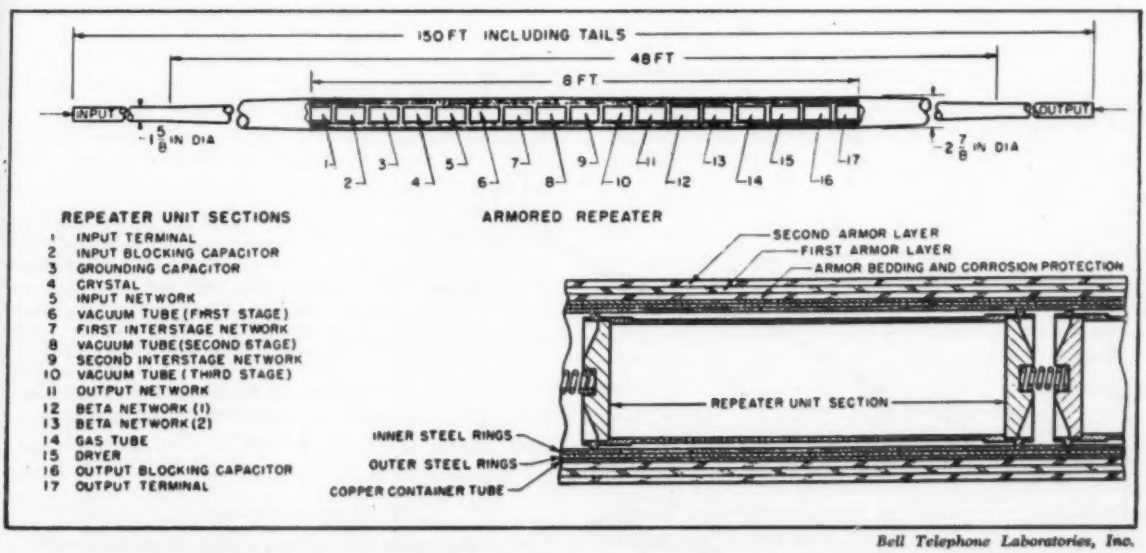
Each repeater is a broad-band amplifier with three stages of vacuum tubes. It transmits a band width from relatively low frequencies to about 144,000 cycles per second. This provides a frequency range for 36 speech channels, each having a band width of more than 3,000 cycles per second, together with space for certain frequencies used in testing the system. If desired, more than one speech channel can be merged to provide a wider band, such as for special radio broadcasts. The total band provided is obviously not sufficient to transmit standard television signals which require a band width of about 4,500,000 cycles per second.

Structurally, the repeater is articulated. The components making up the amplifier are housed individually or in groups in small plastic cylinders about one and one-half inches in diameter and five inches in length. There are 17 such cylinders stacked end to end in the repeater, as shown in Fig. 2. Interconnected, they make up the amplifier circuit. Three of these cylinders house the special long life vacuum tubes. The stacked cylinders forming the repeater proper total about eight feet in length.

Over them are placed two layers of closely fitting, thin steel rings which overlap each other and afford a necessary element of flexibility. They supply the pressure-resisting strength of the container. Over the steel rings is a thin copper tube about one-thirty-second inch in thickness. This is the water barrier. It is sufficiently soft copper to be flexible. At the ends of the articulated structure are a series of elaborate, welded and otherwise constructed seals so that the cable conductors may enter both sides without allowing water or even water vapor to enter the repeater housing. After the cables are attached to both ends, the steel wires are carefully served over the whole structure to insure great longitudinal strength for the over-all cable-repeater combination. The diameter of the repeater section is then about two and seven-eighths inches.

Power is supplied to the tubes by applying positive potential of approximately 2,000 volts to ground to each cable at Clarenville, Nova Scotia, and correspondingly, 2,000 volts negative potential to the two cables at Oban, Scotland, from special high stability, extremely reliable power plants. The current through each cable to operate the tubes, which are, in effect, all in series, is 0.25 ampere, regulated to a constancy of 0.02 per cent. This current flows continuously, without interruption, at all times. From the standpoint of tube life, with such tubes there is actually more harm in turning the current on and off than in allowing it to continue to flow.

Most of the repeaters are connected into the cable at the intervals of about 40 miles before the cable ship leaves the shore. However, some splicing is required during the laying process at intervals of some 200 miles to achieve the precise equalization between the cable losses and amplifier characteristics. A large cable ship, such as the *Monarch*, which is owned by the British Government, makes it possible to carry



Bell Telephone Laboratories, Inc.

Fig. 2. Diagram of structure of submarine repeater built as integral part of deep-sea telephone cable.

Bell Telephone Laboratories, Inc.

Fig. 3. Tube used in submarine telephone cables is conservatively built since it must operate without maintenance at ocean bottom for two decades.

most of the cable and repeaters for a single transatlantic crossing.

If any one of the 300-odd vacuum tubes involved in the two-way transatlantic circuit failed, it would completely disrupt service over all channels. Such an interruption, in addition to the lost service time, might cost several hundred thousand dollars to repair, particularly if it occurred in the deep portion, which exceeds two miles in depth.

A long story could be written about the design of these critical elements. Their development was started early in the planning of the project. The objective was a design which would insure continuity of operation over a period of at least 20 years. This is many times the life of the vacuum tubes used in the average broadcast receiver.

The design of the tubes, one of which is pictured in Fig. 3, is conservative. In particular, the temperature of the filament or emitter is kept much lower than most other vacuum tubes. They are constructed in spotlessly clean, dust-free surroundings with continuous electrical and microscopic inspection to insure that no structural element has inherent weaknesses. Finally each tube is tested on a life rack over a period of several thousand hours – longer than the average life of many vacuum tubes – before it is deemed satisfactory for inclusion in the repeater. Prototype tubes of the type used in the cables were actually tested for over 10 years before the design was approved.

Detailed stories might be correspondingly written about the care in design and construction of all of the other components which make up the repeater, such as condensers, resistors, and so on.

In addition to the deep-sea portion extending from Clarenville, Newfoundland, to Oban, Scotland, about 2,000 miles, as shown on Fig. 4, there is also a section of cable from Clarenville, Newfoundland, down to Sydney Mines, Nova Scotia, about 300 miles in length. This is in comparatively shallow water and a repeater technique, perfected by the British engineers, is employed. In this case, the repeaters are housed in tank-like containers and only one cable is used for both directions of transmission.

From Sydney Mines the telephone circuits derived from the cables are brought into Montreal and New York by connection to a repeatered microwave radio system. Between Sydney Mines and Portland, Maine, this system includes 19 radio relay repeater points spaced about 30 miles on the average.

The ownership of the transatlantic cable project is vested in the American Telephone and Telegraph Company, British Post Office, Canadian Overseas Telecommunication Corporation, and the Eastern Telephone and Telegraph Company.

The conception and early work on the deep-sea cable and repeaters are due, in large measure, to the vision and efforts of men like Oliver E. Buckley, Oliver B. Jacobs, and John J. Gilbert, all of whom are now retired. Dr. Buckley was president of the Bell Telephone Laboratories; Mr. Gilbert was in charge of the project for some time, and Mr. Jacobs made important contributions to the over-all design of the system over many years. Many others, literally hundreds, including a fair share of M.I.T. graduates, played vital parts in the design, construction, and final laying of the various transoceanic cable systems.

For those having an interest in the detailed technical problems involved in this cable enterprise, reference should be made to the *Bell System Technical Journal* of January, 1957, or, for an abbreviated version, the 1955 *Report of the Smithsonian Institution.*

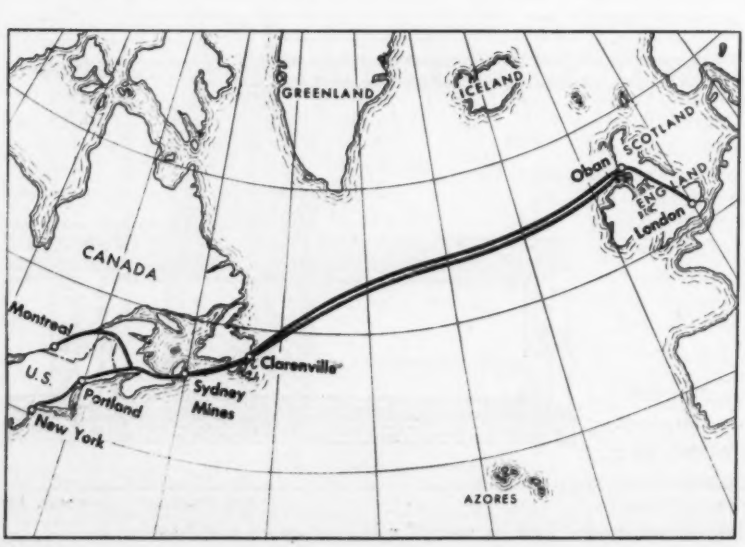


Fig. 4. New York and Montreal are now connected with London by microwave relays and deep-sea underwater cables. Montreal and New York are connected to Sydney Mines by microwave relays. Shallow-water cables connect Sydney Mines and Clarenville. Two cables, one in each direction, connect Clarenville and Oban, Scotland, a distance of 2,000 miles.

Bell Telephone Laboratories, Inc.

The Other Three

In addition to the Erie, three other canals terminating in New York prospered mightily during the Nineteenth Century. But new modes of transportation caused their lingering death in the Twentieth Century

by FREDERIC W. NORDSIEK

THE colorful doings on the old Erie Canal, the trade artery that, in 1825, linked the Atlantic seaboard with the Great Lakes and established New York as the leading city of the United States, are fabled in song and story. Folk singers, professional and amateur, nowadays are often heard to croon:

> "Oh, the E-ri-ee was risin',
> And the gin was gittin' low,
> And I scarcely think we'll git a drink,
> Till we git to Buffalo."

Of the many American works of fiction written around the Erie Canal, one of the best known is Walter D. Edmonds' *Rome Haul.** About halfway through this frothy but entertaining yarn, Dan Harrow, the hero, is talking with Molly Larkins, his "cook,"† about their mutual desire to go to New York some time. They exchange hearsay information about the wonders of that city. Molly says, "You can see boats from four canals, there, all to once." This would have been an historically correct statement any time from the 1830's to the end of the Nineteenth Century. Boats from the famed Erie Canal were of course to be seen then along the New York waterfront as they were towed there in trains, by steam tugs, down the Hudson River from Albany, eastern terminus of the Erie.

But it is safe to say that few, if any, readers of these pages have any inkling of the other three canals that, in prerailroad and early railroad days, poured fuel, lumber, and farm produce into New York, and carried manufactured and imported items – including immigrants – back west. These canals, like the Erie, struggled into being in the face of financial and engineering difficulties, prospered mightily during the heyday of canal transportation, and then died lingering deaths as the railroads tightened their competitive strangle hold, all within the compass of less than a century. These "other three" canals are shown on the map on page 160.

The Delaware and Hudson Canal, opened in 1828 and closed in 1898, began at Honesdale, Pa., and ended in the Hudson River at Kingston, N.Y., whence boats descended the river to New York City.

* Boston: Little Brown and Company, 1929.

†This euphemism was applied to the common-law wives who lived with many of the Erie boatmen.

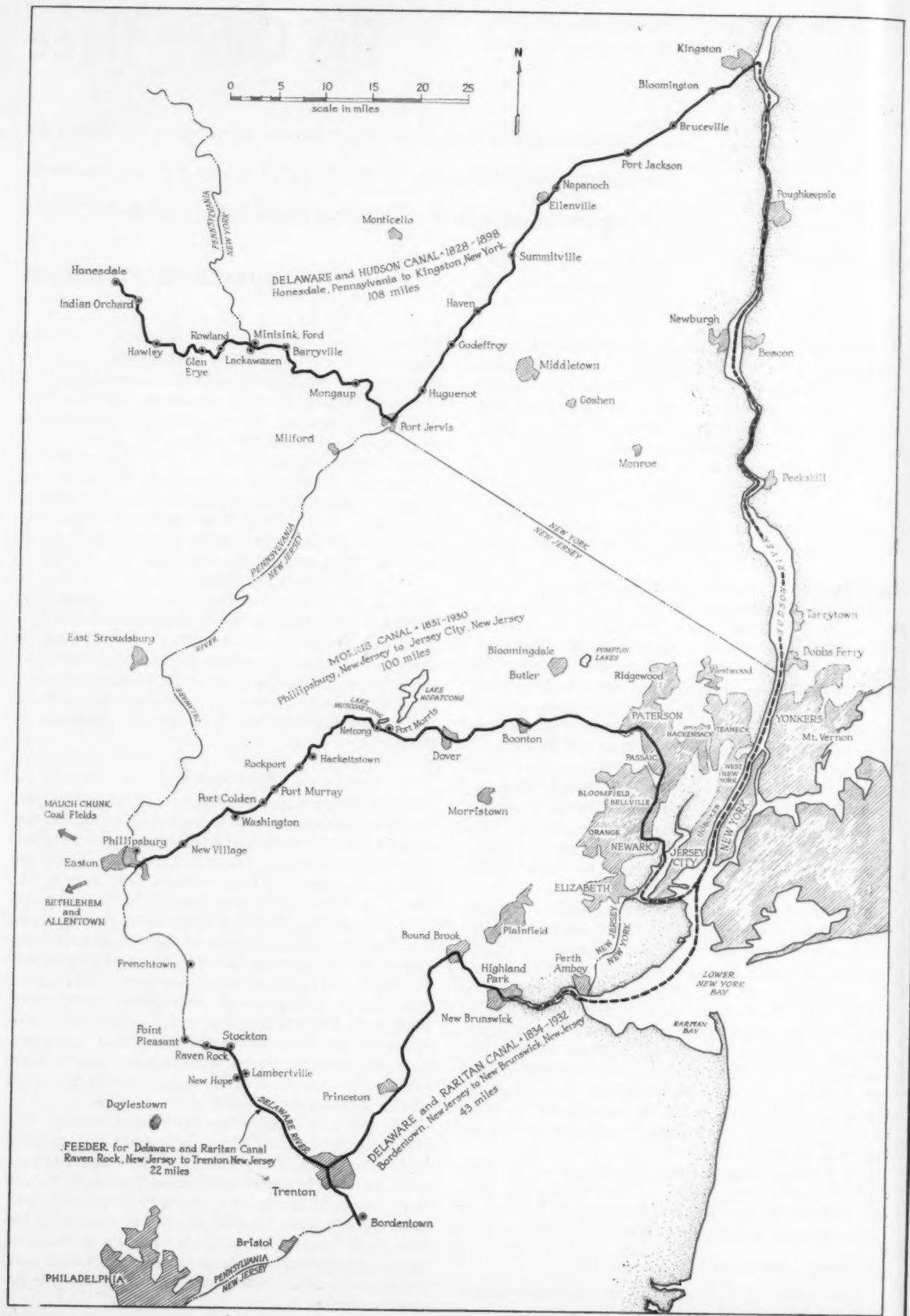
South of the Delaware and Hudson Canal and, like it, running in a generally east-west direction, was the Morris Canal, in use from 1831 until the 1920's. This waterway originated at the Delaware River at Phillipsburg, N.J., and ran 100 miles to end at Jersey City, just across the Hudson River from New York.

Southernmost of the trio is a canal that today still exists as a recreational waterway, the Delaware and Raritan Canal, finished in June, 1834, and closed to commercial use in 1932. This canal, 43 miles long, runs from the Delaware River at Bordentown, N.J., north to Trenton, and then crosses New Jersey to enter the Raritan River at New Brunswick. Thence the boats were towed to New York via Raritan Bay and New York Bay, or by an alternative more sheltered water route west and north of Staten Island. At Trenton this canal is joined by a "feeder," or tributary canal from the north, that starts at the Delaware River 22 miles upstream at the town of Raven Rock, and runs along the east bank of the Delaware to Trenton.

Boat Canals

These three canals were boat canals, a sort that has totally disappeared from the American scene but networked all settled areas of the country in the mid-Nineteenth Century. Today's American canals are either ship canals or barge canals. Ship canals, like the Cape Cod Canal from Buzzards Bay to Cape Cod Bay, or the Welland from Lake Erie to Lake Ontario, can pass large ships of sizes capable of navigating the ocean or the Great Lakes, and serve either as short cuts or as means of access to large inland water bodies. Barge canals, exemplified by the New York State Barge Canal that today parallels or coincides with the route of the old Erie Canal, accommodate power-driven barges with capacities up to 1,000 tons, and serve to connect coastal waterways and similar somewhat sheltered water routes.

The old boat canals were earth-sided ditches, usually some 30 or so feet broad, with manually operated locks. The boats, of capacities not exceeding 100 tons, were manned by crews numbering two or three, and were drawn by horses or mules walking along a towpath. Speeds were limited to three or four miles per hour, both because the animals could go no faster on the long hauls and because greater speeds would have created turbulence in the water sufficient to erode the earthen banks.


0 5 10 15 20 25
scale in miles
N
Kingston
Bloomington
Bruceville
Port Jackson
Napanoch
Ellenville
Poughkeepsie
Monticello
Summitville
DELAWARE and HUDSON CANAL • 1828 - 1898
Honesdale, Pennsylvania to Kingston, New York
108 miles
Honesdale
Indian Orchard
Haven
Newburgh
Rowland
Minisink Ford
Hawley
Glen Eryie
Lackawaxen
Barryville
Godeffroy
Beacon
Middletown
Mongaup
Huguenot
Goshen
Port Jervis
Milford
Monroe
Peekskill
PENNSYLVANIA
NEW YORK
NEW YORK
NEW JERSEY
PENNSYLVANIA
NEW JERSEY
HUDSON RIVER
Tarrytown
East Stroudsburg
MORRIS CANAL • 1831 - 1930
Phillipsburg, New Jersey to Jersey City, New Jersey
100 miles
Bloomingdale
POMPTON LAKES
Butler
Ridgewood
Westwood
Dobbs Ferry
DELAWARE RIVER
LAKE MUSCONETCONG
LAKE HOPATCONG
PATERSON
HACKENSACK
TEANECK
YONKERS
Mt. Vernon
Netcong
Port Morris
Boonton
Rockport
Hackettstown
Dover
PASSAIC
WEST NEW YORK
Port Colden
Port Murray
Morristown
BLOOMFIELD
BELLEVILLE
MAUCH CHUNK
Coal Fields
Washington
ORANGE
NEWARK
HUDSON
JERSEY CITY
NEW YORK
Phillipsburg
New Village
Easton
ELIZABETH
BETHLEHEM
and
ALLENTOWN
Bound Brook
Plainfield
NEW JERSEY
NEW YORK
Frenchtown
Perth Amboy
Highland Park
LOWER NEW YORK BAY
New Brunswick
RARITAN BAY
Point Pleasant
Stockton
Raven Rock
Lambertville
New Hope
Princeton
DELAWARE and RARITAN CANAL • 1834 - 1932
Bordentown, New Jersey to New Brunswick, New Jersey
43 miles
Doylestown
DELAWARE RIVER
FEEDER for Delaware and Raritan Canal
Raven Rock, New Jersey to Trenton New Jersey
22 miles
Trenton
Bordentown
Bristol
PHILADELPHIA
PENNSYLVANIA
NEW JERSEY

◀ *The "Other Three." In prerailroad days, these three boat canals supplemented the famed Erie Canal in pouring freight (largely coal) into New York City, and hauling manufactured and imported items back toward the west.*

Engineering the Canals

Construction of the boat canals was a major engineering triumph of the day. Indeed, striking parallels exist between the obstacles overcome by the old canal engineers and by the designers of today's superhighways, such as the New York Thruway or the Pennsylvania Turnpike. Superhighways must have minimal grades; so did the canals in order to minimize the number of locks, whose construction was costly and whose operation slowed traffic. Other roads, however minor, must be carried over superhighways on viaducts; vast numbers of bridges had to be built across the canals for this purpose. Superhighways cross rivers on large and costly bridges; canals accomplished such transits by means of the most extraordinary of all of the canal structures, aqueducts.

Aqueducts were troughs of water supported on bridges. The weight of the water in these devices made their design particularly difficult, with the result that the cream of the engineering talent of the day was brought to bear upon the problem. John A. Roebling, who 30 years later was to gain lasting fame by designing the Brooklyn Bridge‡ in 1848 built a wire cable suspension aqueduct to carry the Delaware and Hudson Canal across the Delaware River near Lackawaxen, Pa. This structure had four spans, ranging in length from 132 to 142 feet each. According to Roebling himself, in a statement he wrote in 1849, the water in the 142-foot span alone weighed 484 tons! The enduring character of Roebling's work is evidenced by the fact that, when the canal closed, this aqueduct was converted to a highway bridge, and today is still carrying a steady flow of traffic between Minisink Ford, N.Y., and Lackawaxen. Is it not thus the oldest suspension span still in use in this country?

Further analogy between superhighways and the old canals may be cited in connection with tunnels. The Pennsylvania Turnpike goes through seven tunnels in order to maintain its grades between Harrisburg and Pittsburgh; the old boat canals were similarly put through tunnels when necessary. This was done in a day before the knowledge of methods later gained in constructing railroad tunnels was available, when blast holes had to be drilled by hand and blasting was done with black powder and temperamental fuses. A canal tunnel may be seen today along the remains of the Chesapeake and Ohio Canal that ran from Washington, D.C., to Cumberland, Md. Neither the Delaware and Hudson, the Morris, nor the Delaware and Raritan went through tunnels; but the decision not to so construct the Delaware and Hudson greatly speeded the demise of this canal. Upon reaching Port Jervis, 48 miles east of Honesdale, western terminus of the canal, its builders faced the Shawangunk Mountains. Tunneling through this range would have permitted the bringing of the canal straight towards New York, its ultimate goal. But in view of the staggering difficulties of tunnel construction in those days, the canal was planned to bend sharply to the northeast at this point, and to follow the valleys of the Neversink River and Rondout Creek out to the Hudson River at Kingston. But here the boats were almost as far from New York, as the crow flies, as they were where the canal started at Honesdale. The only gain was that the boats now floated in tidewater and could readily be towed to New York. Later, when the Erie Railroad was built through Port Jervis, it penetrated the Shawangunk Range through a tunnel; thus it was able to go straight to New York and to gain an economic advantage that, before very long, put the Delaware and Hudson Canal out of business.

‡ E. H. Cameron, "High Road to Brooklyn," The Technology Review, 48:419 (May, 1946); 48:487 (June, 1946).

Up and Down

Although the three canals to which this article is devoted meandered back and forth a good deal in order to follow contour lines and thus maintain a level bed, nevertheless they had to ascend and descend considerable distances in order to reach their goals. The Delaware and Hudson Canal descended from a 967-foot altitude at Honesdale, Pa., to 480 feet at Port Jervis, N.Y. Then it climbed back to about 530 feet in the vicinity of Summitville, N.Y., and finally came down again almost to sea level at its end at Kingston.

The Morris Canal climbed 830 feet from the Delaware River to Lake Hopatcong, its highest point and incidentally also its principal source of water. Then the Morris descended an equal distance to its termination at Jersey City. The Delaware and Hudson achieved its ups and downs by means of conventional locks – 107 of them. But the Morris threw canal evolution into reverse by employing mostly inclined planes. Inclined planes were used on the canals of ancient China, whereas the canal lock was not invented until the Fifteenth Century. The manually operated locks on the boat canals had a practical limit of rise or fall of about 10 feet at the most. Greater depths not only would have resulted in an undue waste of water when boats locked through, but also would have necessitated lower gates too heavy for efficient operation. That is why the Delaware and Hudson Canal needed more than 100 locks to overcome a total change in level of some 600 feet. The Morris, contrariwise, had only 24 locks. Inclined planes, 23 in number, were used to achieve 1,438 feet of the total 1,661-foot rise and fall. Thus, on the average, the inclined planes each took care of a change in level of more than 60 feet. The planes worked by drawing the boats, one at a time, into cradles that ran on inclined tracks. The cradles were hauled to the top of the inclines by means of water power derived from the upper level of the canal.

About 1830 both the Morris and the Delaware and Hudson were striving to obtain more stockholders in order to finance improvement and expansion of their facilities. They both issued promotional literature, written largely around the relative advantages of locks versus inclined planes. But both canals were put out of business by the railroads before the question was really resolved by long-term practical experience.

Man, Boy, Horse, and Boat

The 1826 annual report of the Morris Canal states that $4.00 per day was the fee paid for "man, boy, horse, and boat." This sum covered wages for a man to steer the boat and a boy to drive the draft animal, feed and rental of the beast, and rental of one of the 25-ton boats then in use. The loaded boats traveled some 20 or 25 miles a day, so 25 tons could be hauled 20-odd miles for a direct outlay of $4.00! Thus is pointed up the main feature of canal transportation — low cost.

The turnpikes of the prerailroad era served well enough for passenger transportation but were expensive for haulage of merchandise or freight. In 1800 the cost of hauling goods 30 miles by road equaled that of transportation all the way from Europe by sea. At that time, coal could be brought from Newcastle, England, to Philadelphia more cheaply than domestic coal could be brought from Virginia by road. When the Delaware and Hudson Canal was first opened, coal was brought by wagon from the Lackawanna Valley coal fields to the canal at Honesdale. For this trip, a horse was able to move three tons of coal. Once at the canal, a horse was able to move a boat holding 50 tons of coal! True, the canals were frozen shut three or four months of each year, but in those days roads were impassable at least as long because of snow and spring freshets.

In England, where some of the old boat canals are still in use, there is sentiment for a swing back to boat canal transportation, even today, with railroads operating all year around. The basis of such reasoning is that the low friction of canal operation means low operating and maintenance costs. Moreover, a canal boat weighs only a fifth as much as its load, whereas a railroad car weighs from half to three quarters as much as its load.

Coal at Their Heels

The Duke of Bridgewater, English canal pioneer (whose canal, opened in 1761, launched the canal era in Great Britain), wrote: "A navigation [canal] should always have coals at the heels of it." He applied his own dictum in extreme measure, because his canal, designed to bring coal from Worsley to Manchester, actually entered his mine at Worsley, and ramified for some 40 miles underground.

But the Delaware and Hudson, the Morris, and the Delaware and Raritan Canals all conformed to Bridgewater's rule; Pennsylvania coal was at their heels, and hauling coal to New York was a major source of their revenue. They were built with this objective in view; thus is demonstrated remarkable vision on the part of their proponents, for, around 1820, steam engines were few in number, central heating of buildings did not exist, and wood for fuel purposes was plentiful. Indeed, the promoters of the Delaware and Hudson Canal found it necessary to arrange public demonstrations in New York of the virtues of their coal as a fireplace fuel. Moreover, in its first years, this canal actually carried more cordwood for fuel purposes than it did coal. Yet in their heyday each of the three canals had to be widened and deepened several times, their locks were reconstructed to accommodate larger boats, and they were operated after nightfall with the help of flares and lanterns in order to feed New York's insatiable appetite for coal. In 1872 the Delaware and Hudson carried a total of 1,700,403 tons of freight, of which 1,409,628, or 82 per cent, was coal.

The Morris Canal in 1845 carried a total of 58,259 tons, of which 28,221 tons was coal. Six years later, 1851, business had boomed so that 536,362 tons, including 298,011 tons of coal, were carried. Thus, while the total tonnage had increased about tenfold, the proportion represented by coal rose from 48 to 55 per cent.

Pennsylvania coal entered the Delaware and Raritan Canal in boats that were locked into the feeder canal at Lambertville, N.J. The boats originated at the coal fields at Mauch Chunk, Pa., whence they followed the Lehigh Canal for 47 miles to Easton, Pa. There they could either cross the Delaware River and enter the Morris Canal, or could proceed south on the Pennsylvania Canal. If they followed the latter course they could reach Philadelphia by remaining in the Pennsylvania Canal to its end at Bristol, Pa., then continuing to the city via the Delaware. If they were New York bound, they locked into the Delaware at New Hope, Pa., crossed the river to Lambertville, N.J., then locked into the Delaware and Raritan Canal feeder.

In 1866, its peak year, the Delaware and Raritan Canal carried 2,857,233 tons of freight, of which 83 per cent was coal.

Passengers by Canal

Today excursionists may take short but delightful trips on the Chesapeake and Ohio Canal near Washington, D.C., or on the Pennsylvania Canal near New Hope, Pa. Both of these disused boat canals have been preserved as recreational waterways, and both are now equipped with scows having benches to accommodate sight-seers. These craft are towed by mules in authentic fashion. The one in Pennsylvania is steered by a man who was a mule boy when this canal operated commercially.

On the old boat canals passengers were a minor but far from inconsequential item of traffic. Canal travel was slow, but immeasurably more comfortable than the alternatives — wagon or horseback via turnpike. Combined freight and passenger boats with crude accommodations carried people at low cost and appealed to immigrants heading west. Deluxe packet boats provided for the more fastidious passenger, although he had to pay as much as $0.04 a mile — big money in the 1830's. By using selected teams of horses, frequently relayed along the route, crack packet canal boats were able to average a dizzying four miles per hour. But by proceeding at night as well as by day, they were able to cover some 100 miles in 24 hours. There was also good business in local travel; thus the Morris Canal had a thriving packet boat line running between Paterson, N.J., and Newark, N.J., a distance of 14 miles. The Morris also advertised a special summertime passenger feature —

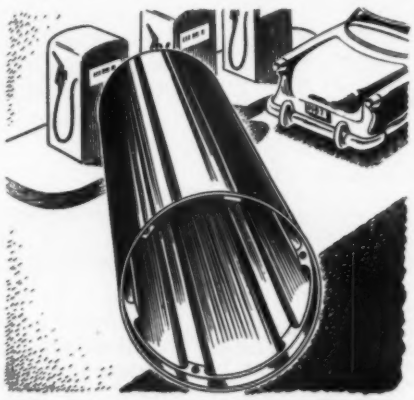
(Continued on page 164)

BUSINESS IN MOTION

To our Colleagues in American Business . . .

When you drive into a gasoline station and ask the attendant to, "Fill 'er up", you may not be aware of it, but in the storage tank beneath the concrete on which your car is standing there may be an electric motor and pump submerged in the gasoline. There is quite an interesting story about this explosion-proof motor.

The use of the positive displacement type of pumping unit in service station operation has presented vapor-lock problems to pump manufacturers for many years. And with the introduction of even more volatile gasoline, present pumping systems have become inoperative in some applications. The use of a submersible pumping unit in the gasoline storage tank therefore has become not only desirable but virtually a necessity.



In designing the pump motor for this type of unit a leading manufacturer had originally planned on using an aluminum casting for the stator, or outside shell of the motor. But when the design engineers considered the factors that would be encountered, and the symmetry of shape, it appeared that an aluminum extrusion might have advantages over a casting.

At this point the manufacturer recalled the numerous Revere copper and brass parts they had been using in their motors over the years, with the utmost satisfaction, and how Revere's T.A. (Technical Advisory) Service had often helped them with similar problems. The result was a huddle with a Revere Technical Advisor to discuss the various pros and cons of castings versus extrusions.

It was found that by using extrusions there would be no problem of porosity which is often present in the case of castings. Substantial savings in weight would also be made as the wall thickness of the stator shell could be reduced, and the only machining would be to the ribs on the inside of the tube. With an extrusion no machining of the outside of the tube is required, which would be necessary should a casting be used, while the smoother surface on the inside improves flow characteristics. This is an important factor in this particular pump motor since the fluid being pumped passes between the stator core and the extruded shell, while in the conventional submersible pump motor a double shell is used. Also, with the smooth surface of an extrusion, less horsepower is used to pump a given volume of fluid. The result was the hollow Revere Aluminum Extrusion you see sketched at left, measuring 13-9/16" long by 3-1/2" O.D.

Here you have still another example of Revere cooperating with the customer in selecting the right metal in the right form to do the best job with the greatest economy . . . be it aluminum, copper or any one of their alloys.

Not only the copper and brass industry but practically every industry you can name is able to cite similar instances. So we suggest that no matter what your suppliers ship you, it would be a good idea to take them into your confidence and see if you cannot make a better product at lower costs by specifying exactly the right materials.

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with tomorrow's
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DEMANDS

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SALT BATH FURNACE — Immersed electrodes provide rapid and uniform heat for several heat-treating processes requiring temperatures from 300° F. to 2300° F.

VERTICAL RETORT FURNACE — A removable sealed retort makes this furnace ideal for carburizing, nitriding, and many other heat-treating processes.

HEVI-DUTY ELECTRIC COMPANY

MILWAUKEE 1, WISCONSIN

Harold E. Koch, '22, *President*
Elton E. Staples, '26, *Vice President*
Chester Meyer, '36, *Assistant Secretary*

THE OTHER THREE

(Continued from page 162)

cool rides on boats carrying ice from outlying icehouses to the city.

Perhaps some of the passengers on the boat canals were not insensitive to the exquisite scenery they floated through so tranquilly. Across the wooded or rustic countryside, the canals wound through verdant river valleys, sometimes entering rocky gorges. In July, 1841, Washington Irving traveled the length of the Delaware and Hudson Canal. From Honesdale he wrote ecstatically to his sister in Paris, saying in part, "For upward of ninety miles I went through a constant succession of scenery that would have been famous had it existed in any part of Europe."

Certainly some of the canal passengers preferred to stay out of doors during their trip; a memoir on the Erie Canal published in the 1820's records that protests were received from passengers about having to leave the deck every time their packet boats passed under one of the numerous low bridges which were built at minimal height in order to minimize the cost of construction. Also recorded is the indignant rejoinder of a canal official who replied that if the passengers did not like it they could just stay off the canals, as there were plenty of excellent turnpike roads available expressly for their accommodation.

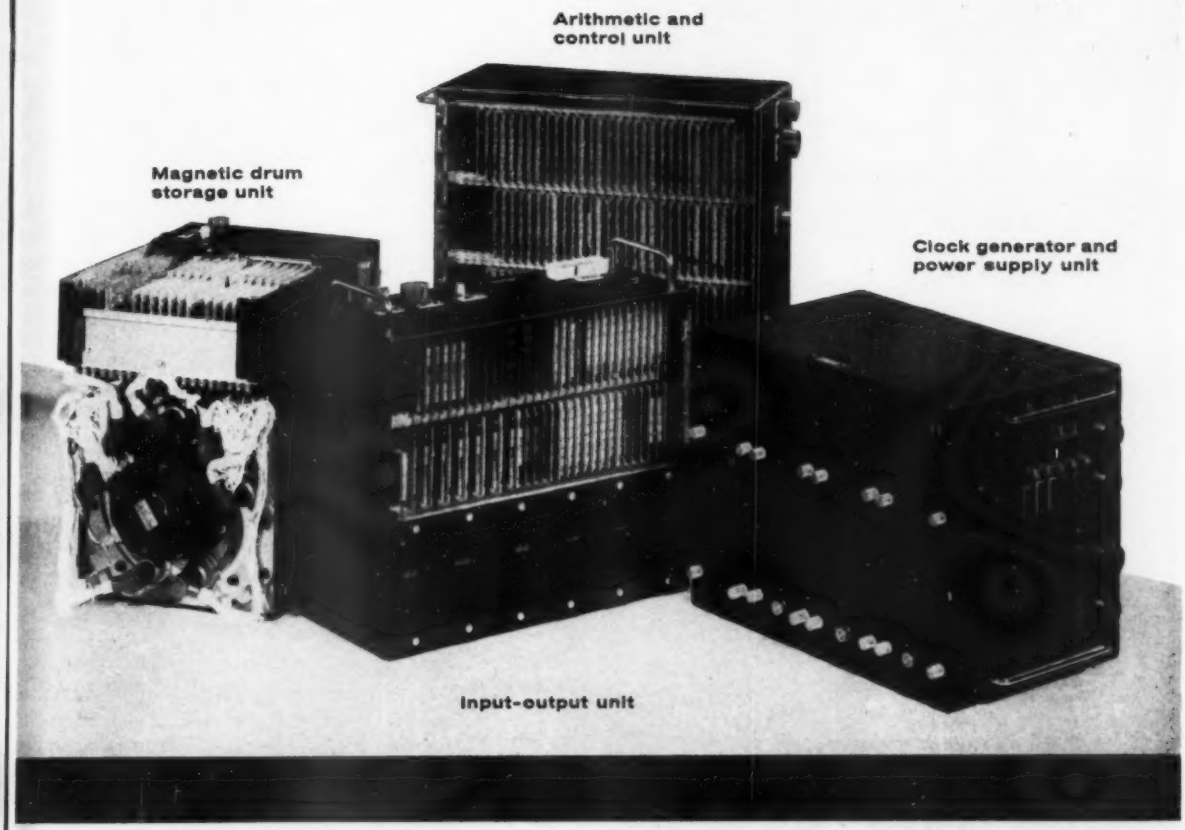
The Canals Today

The Delaware and Raritan Canal exemplifies the happiest of fates for a disused boat canal – preservation by public authorities as a park area. This canal may be seen by riders on the Pennsylvania Railroad's busy main line between New York and Philadelphia, for where the trains cross the Raritan River at New Brunswick, N.J., the canal, running along the west bank of the river, is plainly visible from either side of the train.

In 1934, two years after this canal was closed, the state of New Jersey took possession of it. At each of the locks a dam was built, equipped with sluice gates to pass flood waters. Thus the waterway, sheltered from the wind by its banks and, like all boat canals, having practically no current, became an ideal route for canoeists and fold-boaters, who easily portage their light craft around the dams that replaced the locks.

Towpaths make inviting footpaths for the hiker – indeed, it was hiking that led the writer into his interest in canals. For engineering reasons that cannot be set forth within the space limitations of this article, the old boat canals were built at levels well above those of the rivers they paralleled. Thus, for the pedestrian, the towpath of the Delaware and Raritan Canal provides idyllic, ever-changing, bird's-eye views of the Raritan and Millstone Rivers and their valleys. The path is accessible only to pedestrians or canoeists; hence it teems with unharrassed fauna and flora. Its flora, alas, brings us to the anticlimax. Poison ivy has flourished on the towpath, whose sparse rocky soil is ideal for this vicious pest. The growth is so luxuriant as to make passage diffi-

(Continued on page 166)



The Importance of DIGITAL TECHNIQUES

Digital techniques constitute one of the important developments which have made possible the recent advances in computers and related equipment for computation, data processing, and industrial and military electronic control.

Digital computers for scientific computation range from small specialized units costing a few thousand dollars, to large general-purpose computers costing over a million dollars. One of these large computers is a part of the Ramo-Wooldridge Computing Center, and a second such unit is being installed early this year.

Electronic data processing for business and industry is rapidly growing based on earlier developments in electronic computers. Data processors have much in common with computers, including the utilization of digital techniques. A closely related field is that of industrial process control. To meet the needs in this field, Ramo-Wooldridge has recently put on the market the RW-300 Digital Control Computer.

The use of digital techniques in military control systems is an accomplished fact. Modern interceptor aircraft, for example, use digital fire control systems. A number of Ramo-Wooldridge scientists and engineers have pioneered in this field, and the photograph above shows the RW-30 Airborne Digital Computer.

The RW-30 is an example of what can be accomplished through the application of digital techniques in conjunction with modern semiconductor components. It performs complete mathematical operations, including multiplications, at the rate of 4000 per second (as fast as large scientific computers). Yet it occupies only 4.19 cubic feet, weighs 203 pounds and uses 400 watts power. It is packaged in four separate units to facilitate installation in aircraft. The magnetic drum memory has a capacity of 2607 21-bit words.

The versatility inherent in digital techniques makes it possible for the RW-30 to handle such varied military aircraft problems as navigation, armament control and bombing, and combinations of these problems, without changes in the RW-30 itself.

The RW-30 also serves to illustrate the balanced integration of systems analysis and product engineering which is a principal objective at Ramo-Wooldridge. Similar programs are in progress on other airborne and electronic control systems, communication and navigation systems, and electronic instrumentation and test equipment. Engineers and scientists are invited to explore openings in these fields at Ramo-Wooldridge.

The Ramo-Wooldridge Corporation

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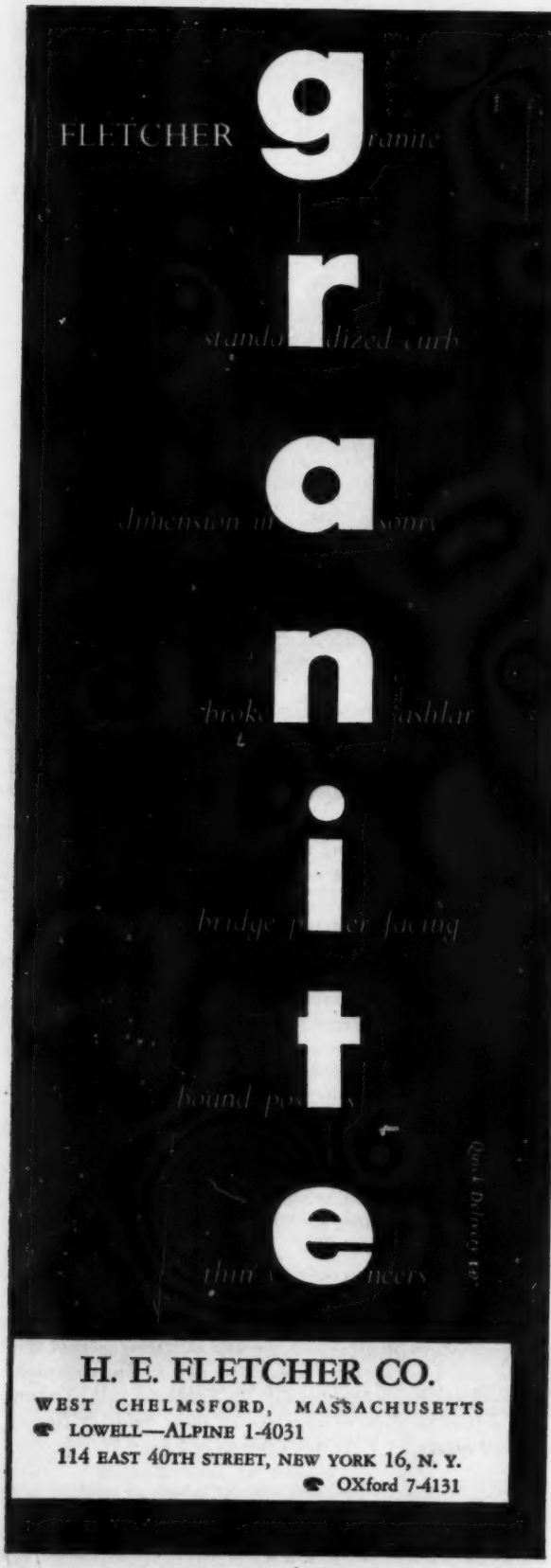

THE OTHER THREE

(Continued from page 164)

cult in winter and impossible in summer. But the State Conservation Department has made a start toward bulldozing the ivy from stretches of the path, and announces that ultimately complete clearance, and destruction of the poison ivy by means of herbicide spraying, will be undertaken.

How can a state afford such extensive rehabilitation and maintenance of a defunct canal? New Jersey pays part of its bills for these activities by selling canal water. The levels of the Delaware and Raritan Canal are such that Delaware River water entering the feeder canal at Raven Rock flows the breadth of the state and empties into the Raritan. These water rights came into possession of the state when it took over the canal. The water is sold to industrial users along the canal route, and also to communities who have found that it can be made potable by suitable treatment. Currently the state sells 39.9 million gallons per day of the canal water, thereby gaining a revenue of more than $100,000 a year.

Canal Memorabilia

But even the canals that are totally derelict have left a lasting impress upon the landscape and upon the map. Their dead-level towpaths may be spotted by the discerning eye in woodland or in farmers' fields, sometimes even within towns; and may often be followed for many miles, bringing one upon remains of locks and other memorabilia. Have you ever wondered why so many eastern towns, near no body of water, are called "ports"? Follow a chain of them with your finger on a map, and you will be tracing the course of an old canal; for these were once thriving canal ports. Thus, in New Jersey, Port Colden, Port Murray, Rockport, Port Morris, and others mark the route of the Morris Canal.

Most of the former canal ports today are little more than names on the map; the names frequently do not appear on latest issues of maps made by the U.S. Geological Survey. Others, like Port Jervis, N.Y., have had a different fate. The locale of this community was first just a junction of two rivers, called Carpenter's Point. When the Delaware and Hudson Canal opened, a bustling canal port soon sprang up here and was named for John B. Jervis, chief engineer of the canal, who had learned his specialty helping to design the Erie Canal. The Erie Railroad put the quietus on the Delaware and Hudson Canal, but this railroad found Port Jervis to be a strategic location for extensive yards, shops, and roundhouses. The town survived, in time added manufacturing and summer hotels to its resources, and ultimately became a city.

Old Canal Structures

Use of the abandoned aqueduct of the Delaware and Hudson Canal, near Lackawaxen, for a highway bridge has been mentioned. For a time the city of Rochester, N.Y., had an abortive rapid transit sys-

(Concluded on page 168)

American Cyanamid Company Florida
Anaconda Aluminum Company Montana
Atlas Powder Company Tennessee
Caterpillar Tractor Company Colorado
Corning Glass Works Ohio
General Electric Company North Carolina
General Mills, Inc. Ohio
General Motors Corporation Michigan
International Business Machines Kentucky
Johns-Manville Corporation California
Koppers Company, Inc. Pennsylvania
Mead Corporation, The Tennessee
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THE OTHER THREE

(Concluded from page 166)

tem that ran in the dry bed of the old Erie Canal. Lock houses – dwellings for lock tenders – on the Chesapeake and Ohio Canal were built in enduring fashion from solid stone. When this canal became a public park, these buildings were offered for sale as homes; many have been bought by people who do not mind owning a house on land they can never own. Lock House No. 1, where this canal began, may be seen today in Washington near the White House at the corner of 17th Street and Constitution Avenue. It is perfectly preserved and duly labeled with bronze tablets as an historical site; but it also serves a utilitarian function as a public toilet.

West of Port Jervis a resident has dammed a bit of the otherwise dry Delaware and Hudson Canal to make a sightly duck pond. The town of Waterloo, N.J., has similarly dammed and flooded a stretch of the Morris Canal that serves the townspeople as a swimming pool in summer and a skating pond in winter. Ice skating on a boat canal before the first snowfall is a special experience; the sheltered, currentless water forms an ice of crystal transparency usually known locally as "black ice." Skating on this surface, especially if none has gone before, is a sensation akin to free flight. Black is an appropriate funereal color for canal ice, as it was the freezing of the canals for several months each year that made them succumb before the competitive onslaught of the year-round railroads.

Escape from Reality

Aside from the interest of ice skaters, canoeists, hikers, and conservationists in preserving at least remnants of the boat canals, these old waterways have become a strong focus of that particular escape from rude present-day reality that finds its outlet in antiquarian interests. On October 13, 1956, at Buffalo, N.Y., a Canal Society of New York was formed to pursue such nostalgic ends.

Thus the old boat canals, though long gone from the scene, will probably not soon be forgotten. Will such a mellow fate befall the railroads, that in their day killed the canals, but are now locked in lethal struggle with air lines, busses, trucks, and pipe lines?

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HIGH-TALENT MAN POWER

(*Continued from page 154*)

vocationalized college training. The engineering or scientific specialties of today may not be those which will be important tomorrow. Thus, industry should search for minds with the capacity to grasp new ideas, rather than just for specialized technicians who can make an immediate contribution to problems which may be of only transitory urgency.

It is difficult, of course, to spot this kind of talent just by interviewing the candidate for a few hours, giving him some tests, or even talking to his professors who presumably know him best. The interviewer can screen out men who are too timid or too brash to be likely to succeed, but the interview is not much more than a salesman's call. Psychological tests are useful, but they are more effective in determining shortcomings than in discovering high talent, and teachers unfortunately do not always know the students as well as you might assume. In the last analysis, motivation, emotional maturity, and intellectual capacity are best tested over time and in the light of resistances and pressures. For this reason, the really progressive companies attempt to employ men in the summer vacations before graduation. In this way, both the company and the man can test out each other.

The placement and orientation of the new recruit is also of critical importance. There is, I feel, an overemphasis on immediate monetary offers in the attempt to attract and hold young men of high talent. And, as a rule, such young men are by temperament and education more concerned with individual accomplishment than with automatic or across-the-board impersonal rewards. It is poor policy, I think, for a company to pay the same salary to all engineers of a type regardless of their relative contribution, for this merely wastes the value of differential rewards to men of particularly high talent who are most sensitive to the symbols of individual accomplishment.

Furthermore, no amount of pay will satisfy the man who thinks that his time is being wasted, who feels that his supervisor does not understand the nature of professional work, who thinks that his opportunities to learn are limited, or who fails to get individual credit for the ideas he advances. Indeed, the worst mistake in dealing with men of high talent

(*Continued on page 172*)

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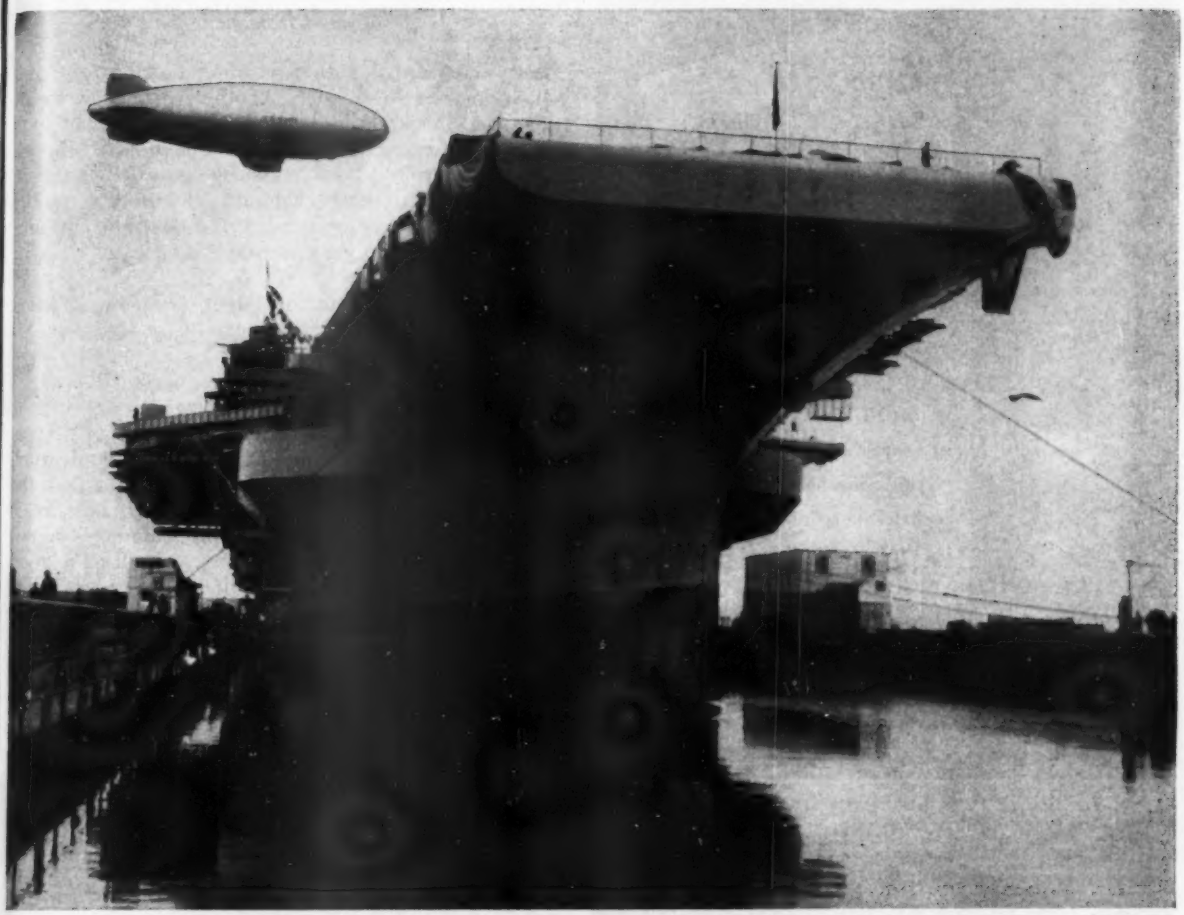

The U.S.S. Forrestal (above) and the U.S.S. Saratoga are both fitted with equipment engineered and built by C. H. Wheeler. The U.S.S. Ranger, the U.S.S. Independence and the U.S.S. Kitty Hawk, now under construction, will also be Wheeler-equipped.

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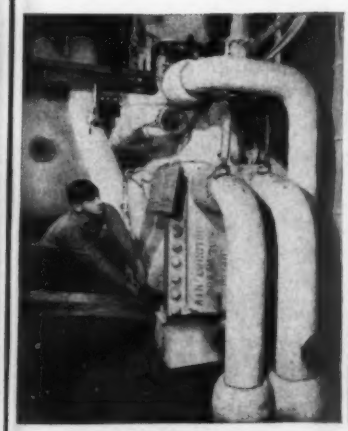
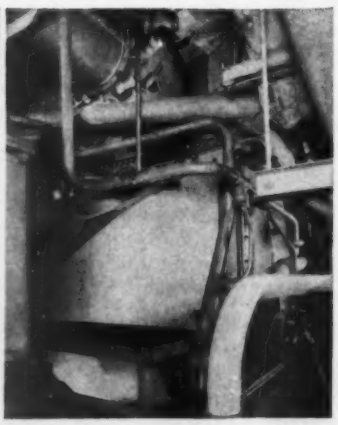


Vacuum Drain Tank Ejector, built by Wheeler, which has been installed in the U.S.S. Saratoga, sister ship of the U.S.S. Forrestal (above).



Main Condenser (forward) on U.S.S. Saratoga. Nearly all U.S. Navy ships—even atomic submarines and supercarriers—have Wheeler equipment aboard.

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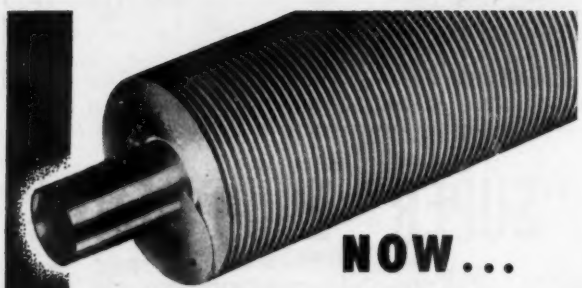

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HIGH-TALENT MAN POWER

(*Continued from page 170*)

is to assume that high pay automatically liquidates their interest in an idea. Another mistake is to attempt to stockpile high talent against times of high demand or rapid expansion — that is, to have a bunch of brains around on a stand-by basis. High talent, unlike materials and machinery, deteriorate rapidly if not used; it decomposes if it is denied the stimulus of growth; it requires accomplishment to keep its tone.

Obviously, the man of talent must be handled carefully. Of course, he too has a lot to learn; his rough edges require some sandpapering. He must learn that the time span from a brilliant idea to a change in production is usually quite long; and he must understand also the deliberate pace of a large organization, the uncertainties of communication, the delays involved in getting clearances, and the need for a certain amount of order and consistency in the handling of people. For this reason, his supervisor needs to be a good teacher as well as a good manager, and he must have the capacity to direct, rather than to stifle, aggressiveness and initiative on the part of the newly hired engineer or scientist who much-too-often has an all-too-high opinion of himself and a quite-too-low respect for the wisdom of his more experienced associates. Here again we are face-to-face with the problem of management and the selection and development of high-level supervisors, administrators, and executives.

All corporations can help educational institutions do a better job in preparing persons for scientific and technical careers. They can establish closer connections with colleges through arrangements for co-operative students and co-operative teachers. They can encourage students in high schools to prepare themselves better in mathematics, English, and science. And, of course, they can and should provide financial assistance to the institutions which are capable of doing a good job. But, companies should not confine their interest to programs for increasing the numbers of technical people who enter and graduate from colleges. They should be even more concerned with the quality of talent being developed.

Here again, I cannot stress too strongly the necessity for broad education of those planning to enter engineering, for firm grounding in mathematics, in

(*Continued on page 174*)

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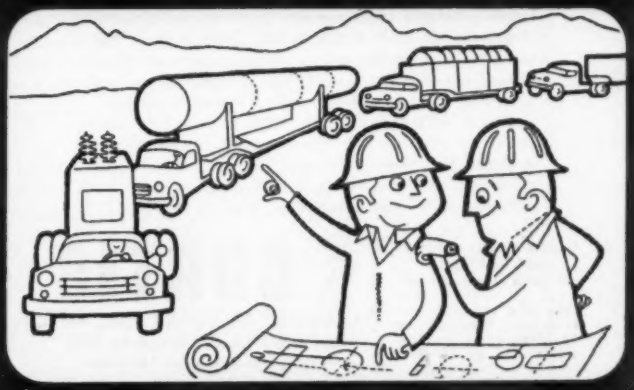

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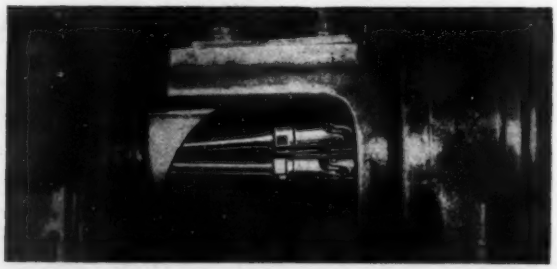

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HIGH-TALENT MAN POWER

(*Continued from page 172*)

scientific theory, in comprehensive use and understanding of the English language, and also in the social sciences and the humanities. Industry will sell itself and the younger generation short if it advocates the crowding of the curriculum with too many practical courses, too much attention to techniques and gimmicks; in short, too much emphasis on vocational rather than upon basic education. The practice or the art of engineering is not something that can or should be taught in college. In this respect, the demand on the part of some companies for more practical and more specialized training in colleges is, in essence, an indication only that these companies are not competent to undertake their rightful training responsibilities.

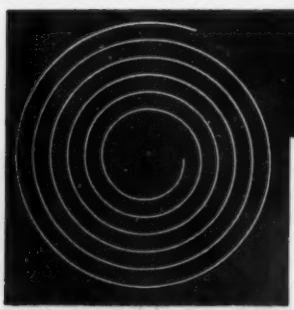
Conclusion

By way of conclusion, let us briefly examine the impact of the changing structure of man-power utilization upon our thinking in the field of industrial relations.

For the past two decades, collective bargaining with manual workers has occupied the center of the industrial relations stage. Unions have directly or indirectly exerted pressure on all levels of management. As a consequence, there has been a virtual revolution in the handling of human relations in American industry. This has been decidedly beneficial. Unions are here to stay, and collective bargaining has become a permanent and necessary function in business operations. As a result, the freedom, dignity and worth of the individual worker in American society has been greatly enhanced.

Much of our effort in the past has been directed toward treating the common man fairly and equally. Seniority systems have been created to eliminate favoritism and discrimination; job evaluation has been used to provide equal pay for equal work. In working on things such as general wage increases, call-in pay, overtime, compensation for work on Saturdays and Sundays, vacations, pensions, supplementary unemployment benefits, sickness benefits, and related matters, the concern has always been to establish rules for equal and nondiscriminatory treatment of the various categories of manual and clerical

(*Continued on page 176*)



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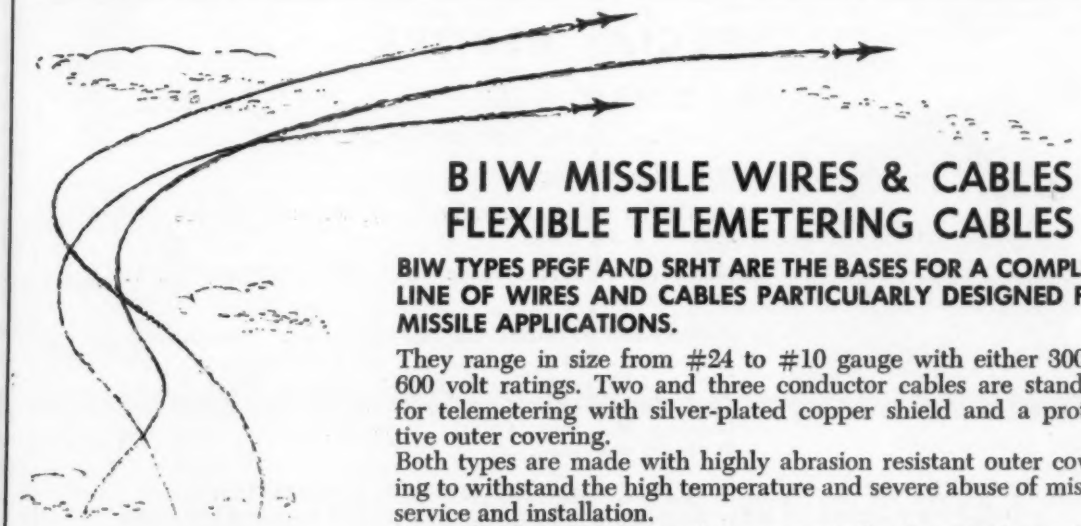

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HIGH-TALENT MAN POWER

(*Continued from page 174*)

labor. Above all, we have been interested in achieving conformity and consistency. We have become skilled in the arts of classification and categorization. In fact, industrial relations practices may be plagued today with an ailment called "a hardening of the categories!"

But, the skills and the concepts which have been useful in dealing with the common man are not always those most appropriate for dealing with high-talent man power. Today, we have been talking about the engineer, the scientist, the professional person. He is the *uncommon man*, the atypical being, the brainy guy, or the egg-head with queer but nonetheless valuable ideas. When you hire professionally trained people today, you are hiring persons who by their education and their pre-employment indoctrination are individualists and inclined to be nonconformists. They want recognition as individuals, as originators of ideas – as professionals; they are not content to be dealt with by categories.

In dealing with technical man power, therefore, one needs to know how to detect the differences rather than the similarities between people. Objective discrimination and differential treatment are the vital skills required for selection and effective utilization of high-talent man power. But, it is far more difficult for a manager to deal with people differently than to treat them uniformly. For the last 10 years, industry has been trying to train managers to eliminate discrimination in order to treat all people fairly. Now, it is becoming necessary to help them differentiate in order to motivate outstanding individuals substantially.

There has been both understandable concern and wide speculation regarding the unionization of professional and technical personnel. Some forces tend to favor their unionization. For example, large aggregations of engineers and scientists are now employed in the rapidly expanding research and development laboratories. To the extent that they are treated like other large aggregates of workers, they may logically seek to organize for the purpose of bargaining collectively with management. Professional workers have both aspirations and grievances, and they will not easily submit to the unilateral exercise of authority by any company. It is significant that the few unions of engineers and scientists which exist today have as one of their major goals in bargaining the recognition of the professional interest and status of their members. If management persists in thinking of them as a category instead of as individuals, then the movement toward unionization may gain momentum.

On the other hand, there is good reason to expect that professional personnel will not be organized. Engineers and scientists are in such short supply that

(*Concluded on page 178*)

SPECIAL REPORT

Mr. ROLLINS WM. MILLER, JR. NEW YORK LIFE AGENT

at WASHINGTON, D. C.

BORN: June 11, 1921.

EDUCATION: Georgetown University, Foreign Service School, B.S., 1950.

MILITARY: U.S. Marine Corps—Tech. Sgt., January '42 to November '45.

PREVIOUS EMPLOYMENT: March '48 to Sept. '48—U.S. State Dept. Oct. '48 to June '49—Secretary, Dept. of Physics, Georgetown University. March '50 to Aug. '50—Sales Trainee, Manufacturer of Electronic Business Machines. August '50 to August '51—Salesman, Business Machines.

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(*Concluded from page 176*)

they can force management to respect their interests as individuals. This has seldom been the case with manual workers. They have usually needed the help of government and the pressure of strong unions to force employers to meet their demands. Men of high talent, on the other hand, can use the pressure of the market to seek their ends. For this reason, perhaps, management will be impelled to deal intelligently with the grievances and aspirations of professional personnel before they come to feel that collective action would be necessary to bring pressure on their employers. In other words, I am suggesting that improvement in the management and motivation of high-talent man power probably will not wait upon unionization except perhaps in a few of our more backward enterprises.

In any case, the future holds many intriguing problems and new challenges for the industrial relations officer. As the staff adviser to top management on human relationships, he will have fresh opportunities to make his highest contribution to his company and to his country as an idea-man, as an innovator, and as a restless fellow more concerned perhaps with forward planning than with the particular problems of the day. He can play his most strategic role as a thinker, a needler, and often a nonconformist. In the area of devising the means for the more effective management and motivation of high-talent man power, he has before him worlds to conquer. And here, unlike the arena of collective bargaining, he may not find so many lawyers moving in to help him do his job!

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and the prophet replied:
*"It is well to give when asked, but it is better to give unasked, through understanding."**

Gifts by Will

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The tale is told of Almustafa, the prophet, who, having awaited for many years the ship that would return him to the place from whence he came, was making the final descent to the shore when the folk of Orphalese crowded about him. They besought him before departing to "disclose us to ourselves, and tell us all that has been shown you of that which is between birth and death."

With words of wisdom, an answer appropriate was given to the woman holding a baby, to the ploughman, to the merchant. Begged one, "Speak to us of GIVING," and the prophet replied:

> "It is well to give when asked, but it is better to give unasked, through understanding;
> And to the open-handed the search for one who shall receive is joy greater than giving. All you have shall some day be given;
> Therefore give now, that the season of giving may be yours and not your inheritors'."

Through the years the prophet's words have held true, for even today he who "through understanding" includes the MASSACHUSETTS INSTITUTE OF TECHNOLOGY as a beneficiary in his will can experience thereby a two-fold satisfaction. The successful culmination of his search for a worthy recipient and the anticipated results his generosity will assist in accomplishing. These satisfactions give an added value to the span of man's days and project his usefulness to his fellowmen far into the future.

The Massachusetts Institute of Technology because of the high quality of the education given its students, its effective research work for aiding America in peace as well as in war, and the high character of its governing body and academic staff qualifies as an institution for serving our American ideals for the present and in the years to come.

But the search, the finding, and the anticipated accomplishments are not enough; for without the properly-worded record, man's plan for the future may go awry. Hence the prophet's importuning, "— give now," should be heeded. The giving need not be an immediate physical transaction, for written directions replace the spoken word when the speaker is no longer present, and a donor can frequently make by will a gift which is larger than he can make while living. Truly, *"it is well to give when asked, but it is better to give unasked, through understanding."*

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* "The Prophet" by Kahlil Gibran

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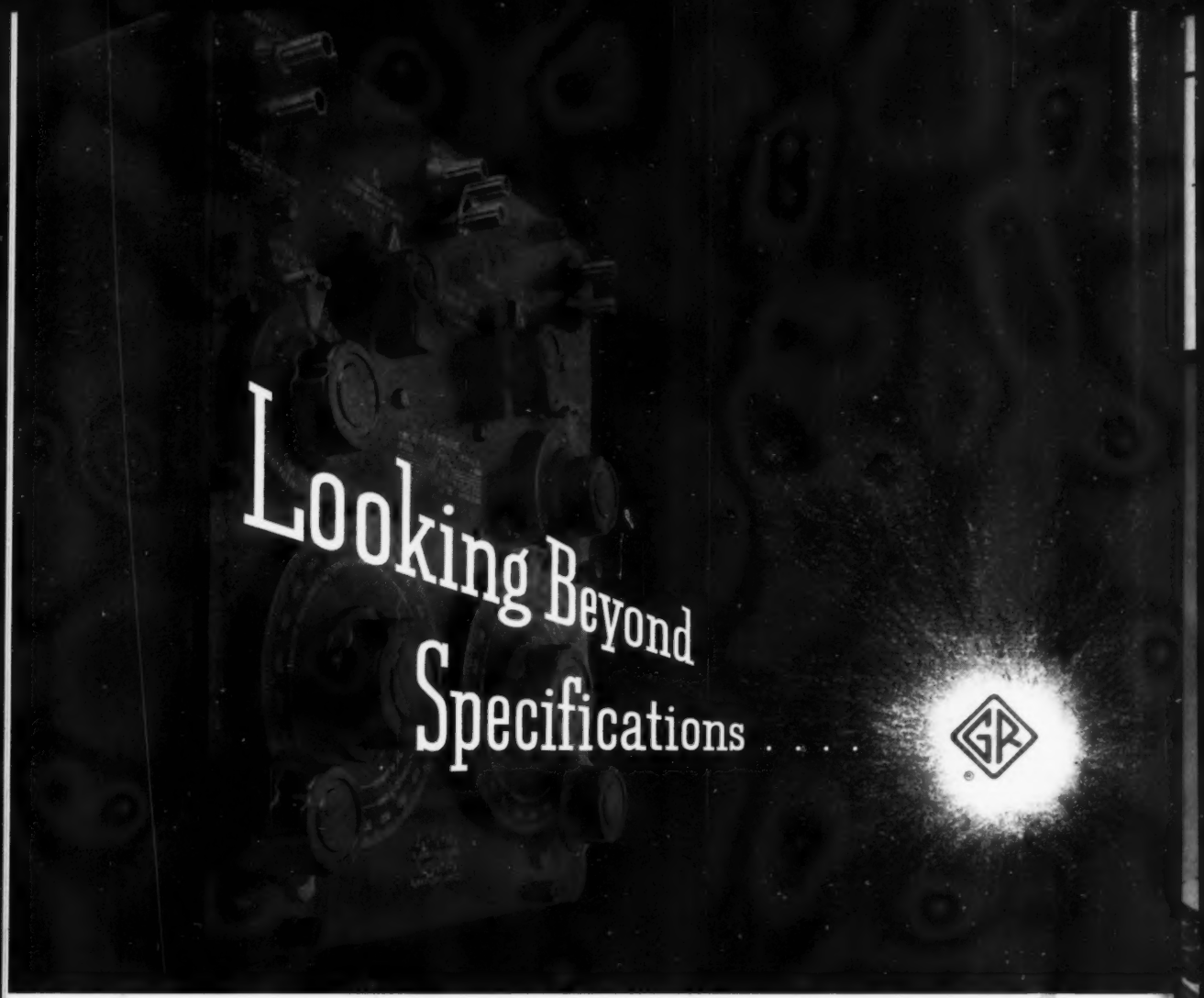

Specifications never tell the complete story. Quality, for example, is not included, because it cannot be measured, only evaluated. Quality is made of many things — the engineer's approach to the design problem and how well he solves it . . . the workmanship that translates his thoughts into reality . . . the care and individual consideration given each product during calibration to assure exceptional performance . . .

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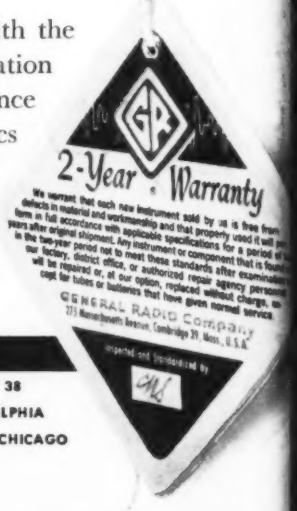

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